

ANNALS OF SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

EDITED BY
LEWIS STEPHEN PILCHER, M.D., LL.D.,
OF NEW YORK

WITH THE COLLABORATION OF

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No. 1

FURTHER OBSERVATIONS ON THE RESULTS OF BLOOD TRANSFUSION IN WAR SURGERY

WITH SPECIAL REFERENCE TO THE RESULTS IN PRIMARY HEMORRHAGE

By L. BRUCE ROBERTSON, M.B. (TORONTO), MAJOR C.A.M.C.

WITH A NOTE BY

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IN a previous paper¹ the results of blood transfusion in a few cases of secondary hemorrhage were given, with a description of the Lindeman syringe-cannula method.² Since that time opportunity has arisen of extending its application to cases of severe primary hemorrhage accompanied by shock. The results of these cases are presented in this paper. In four cases of this series the citrate method was used; one case was done with the Unger two-ways stop-cock. The remainder were done by the Lindeman syringe-cannula method.

The results have shown: First, that certain cases heretofore considered as inoperable, and others as exceedingly bad surgical risks, often may be revived to a degree which not only permits of radical operative measures, but ensures a good prospect of ultimate recovery. Second, in other cases in which the post-operative condition is one of progressively increasing shock, due to the initial loss of blood and to the severity of the operative measures required, blood transfusion is a permanent resuscitative measure of extreme value.

It has been the unhappy lot of every surgeon in a casualty clearing station to have cases admitted under his care which from an operative standpoint required immediate attention, but which were in such a collapsed and exsanguinated condition that operation was quite out of the question. In certain of these cases a short operation (frequently amputation) is all the immediate operative treatment necessary, but the patient is unfit to withstand any operation owing to loss of blood and shock. Case 10 is typical of this class.

The Time for Blood Transfusion.—The time at which blood transfusion should be done is a point which merits the closest attention. If the bleeding point can be controlled, as, possibly, in the case of a shattered leg or thigh, the ideal time is as soon as the patient is seen. If operative interference is

¹ Robertson, L. B.: Brit. Med. Journal, July 8, 1916.

² Lindeman, Edward: Amer. Jour. Dis. Child., July, 1913.

necessary before the bleeding can be controlled, *e.g.*, in intra-abdominal hemorrhage, blood transfusion may be carried out before the patient leaves the operating table. Usually, however, one is tempted to employ the ordinary resuscitative measures before resorting to blood transfusion, and in this connection it is wise to sound a warning that one should not wait too long.

Clinical observation appears to show that some degenerative changes take place in the organism when the exsanguinated condition persists for more than a few hours. If the patient is allowed to reach this stage he does not receive the same amount of benefit from the transfusion, as he would if it were given earlier. For this reason it is advisable to give the blood as soon after admission as circumstances permit.

Other great factors besides loss of blood in the production of that complex condition called shock are loss of body heat and physical exhaustion. After blood transfusion has been done these other factors may be combated by providing warmth and rest for a few hours before operation. Acidosis incident to the shocked condition may be treated by the administration of sodium bicarbonate.

With regard to the development of sepsis in these severely wounded and exsanguinated patients, it is obvious that there is a greater liability to the development of severe infection during their subsequent progress than if the anæmia were decreased by the addition of fresh blood. The benefit of blood transfusion has its limitations and it should not be used indiscriminately. It is, for example, of more limited value where gas gangrene has already developed, and should not be done unless the infected area can be either brought under control by excision or free drainage, or eliminated by amputation.

Amount of Blood to be Transfused.—This depends largely upon the giving capacity of the donor and the receiving capacity of the patient. A small patient will require proportionately less blood than a large heavily-built patient to produce the same effect on pulse and blood-pressure. In the cases of severe primary hemorrhage 700 to 1000 c. cm. may be regarded as an average amount, and will usually tide the patient over his crisis. Smaller amounts have been given with some success, but the most immediate and lasting improvement has been obtained with the large amounts. Cardiac dilatation in these exsanguinated recipients has not been observed even with the larger amounts given. In transfusing 1000 or 1200 c. cm. the intervals between the injections of the blood-filled syringes should be longer towards the latter part than at the beginning of the procedure, and the minimum amount of saline should be introduced into the recipient's vein between the injections of the blood-filled syringes.

In different donors the effects of loss of blood will show themselves at different times according to the size and robustness of the donor, the amount of blood, and the rate at which it is removed, and the particular method employed. An impressionable donor will exhibit symptoms earlier than one

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of phlegmatic temperament. In none of the donors has anything more than a temporary disturbance been observed. This coincides with the observations made by Colonel Fullerton,³ who had the opportunity of keeping donors under observation for some considerable time after they had given blood to patients.

The advisability of transfusing blood in the following cases was determined by the general condition of the patient, the pulse, and evidence of severe hemorrhage, the prospect of recovery after transfusion and operation, and in the later cases the blood-pressure. A wounded man who has lost much blood and has a blood-pressure below 90 mm. Hg is not a good subject for operation; with a blood-pressure below 70 mm. Hg he is

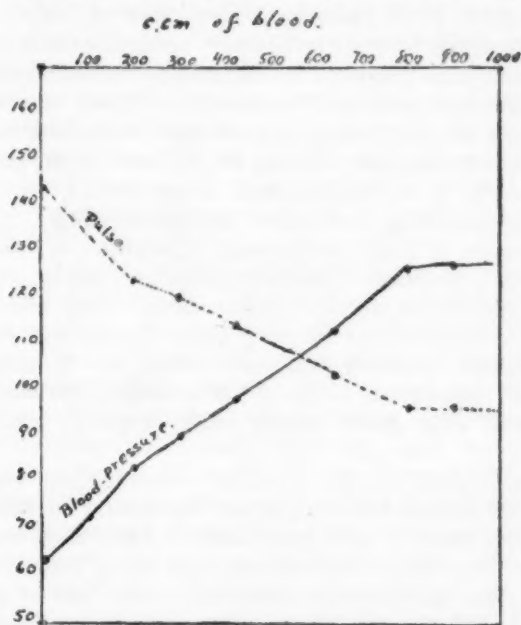


FIG. 1.—Chart of Case XXIII, showing fall in pulse-rate and rise in blood-pressure during the course of the transfusion of 1000 c.cm. of blood.

in a precarious condition. Loss of blood intensifies to a very great degree the amount of shock produced by traumatism, and in the majority of such cases the immediate issue depends upon control or elimination of the effects of hemorrhage.

Immediate Results.—In the cases of severe primary hemorrhage accompanied by shock blood transfusion frequently produces an immediate and almost incredible improvement. The change from a pallid, sometimes semi-conscious patient with a rapid flickering pulse to a comparatively healthy-looking, conscious and comfortable patient with a slower and fuller pulse is dramatic evidence of the value of the transfused blood. The blood-pressure readings before and after blood-transfusion have shown the re-

³ Fullerton, A., Dreyer, G., and Bazett, H. C.: *Lancet*, May 12, 1917.

markable change produced by the new blood. In these cases in which readings were taken during the subsequent 48 hours it was shown that this rise in blood-pressure was well maintained. This is in marked contrast to the transient effect on the blood-pressure of normal saline injections. The accompanying chart (Fig. 1) illustrates the gradual fall in pulse rate and rise in blood-pressure during the blood transfusion. The immediate result of the transfusion is that it places the patient more on a footing with a man similarly wounded who has not lost more than a moderate amount of blood.

CASE REPORTS

CASE I.—Rfn. T. M., admitted November 23, 1916, in extreme collapse. Compound fracture left femur, femoral vessels severed. Intravenous saline was followed by temporary improvement for some hours, but condition was still inoperable. Blood transfusion (800 c. cm. by Unger two-ways stop-cock) done. Immediate improvement. Amputation above fracture. Death in 36 hours from gas-gangrene.

CASE II.—Pte. J. S. S., admitted December 10, 1916, shattering fracture of leg involving knee-joint; profuse bleeding. Had received intravenous saline at Field Ambulance. Condition of collapse; pulse 134 and barely perceptible. Blood transfusion (500 c. cm. by citrate method); moderate but definite improvement. Two hours later, amputation above knee. Next morning pulse 82, general condition immensely improved. Further progress uneventful. Evacuated to base in two weeks. Note from England four months later stating that re-amputation had been done; stump healed rapidly; patient's health good.

CASE III.—Driver F. H., admitted December 29, 1916, in poor condition. Left foot blown away, severe compound fracture right foot, and penetrating wounds both knee-joints. Anti-shock measures carried out, and when some improvement had taken place wounds were dealt with. Post-operative condition bad. One litre of gelatin solution (Hogan) intravenously—some improvement. Following morning condition very poor—blood transfusion done (750 c. cm. citrate method). Marked reaction but some improvement, which was only temporary. Died in 20 hours. Hæmoglobinuria present. There is no doubt that death was hastened by the occurrence of hæmolysis.

CASE IV.—Sapper B. O. J., admitted January 6, 1917, under the care of Captain S. J. Streight, C. A. M. C. Had bled profusely from a ragged perforating wound of left shoulder. Compound fracture of scapula and head of humerus. Anti-shock measures instituted. Twelve hours later operation was done; shattered humeral head removed, torn circumflex vessels tied. Post-operative condition became progressively worse. Six hours after operation blood-transfusion (760 c. cm. by citrate method). Improvement immediate. Before transfusion blood-pressure, systolic, 75; diastolic, 40. Next morning: systolic, 100, and diastolic, 75; improvement progressive. Evacuated to base 4 days later. Two months later he died at a base hospital from empyema fol-

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lowing pneumonia. The progress of the wound had been slow but good.

CASE V.—Pte. R. F., admitted February 3, 1917, in collapse. Severe multiple wounds of both lower limbs (left leg almost severed), and left forearm and hand. Anti-shock measures instituted. Ten hours later, when some improvement had occurred, operation was done. Intravenous saline at operation. Post-operative condition very poor. Blood-transfusion (660 c. cm. by citrate method) done 5 hours later. Slight improvement which was not maintained. Died 7 hours later from shock.

CASE VI.—Pte. T. B., admitted in night of February 7, 1917, in very poor condition. A shell fragment had severed left popliteal artery, and condition had been so bad that he had been unfit for transport from Field Ambulance for several hours. Anti-shock measures were instituted and some hours later blood-transfusion (700 c. cm.) done. Three hours later amputation above seat of injury. Patient withstood operation well, but gas-gangrene was present in the stump the next day. Infection controlled by free incision. Five days after amputation died very suddenly with signs of pulmonary embolus. Autopsy disclosed long clot extending from tied end of femoral vein to junction with internal iliac vein.

CASE VII.—Pte. A. T. H., admitted February 27, 1917, bullet wound penetrating abdomen. Sixteen hours after laparotomy pulse became much weaker and more rapid. Blood-transfusion (1000 c. cm.) done: remarkable and immediate improvement, pulse dropping from 140 before to 108 after transfusion. Patient died 30 hours later from gas-bacillus infection in a large retroperitoneal hæmatoma.

CASE VIII.—Pte. T., admitted April 21, 1917, under the care of Captain William Beggs, C. A. M. C., in severe collapse. Bleeding from a shattered forearm had been profuse. Anti-shock measures. Five hours later circular amputation done. Post-operative condition became progressively worse for five hours, when blood-transfusion (1160 c. cm.) was done. Immediate improvement. Before transfusion: radial pulse 120 and barely perceptible, lips and face colorless. After transfusion: pulse 85 and of good tension, face showed much improved color. Four days later: secondary amputation, flaps closed. Evacuated to base on fourth day in excellent condition.

CASE IX.—Cpl. F., admitted under the care of Captain Beggs, C. A. M. C. Severe multiple wounds of arms and legs. General condition very poor. Anti-shock measures for some hours, then amputation of left leg and other wounds dealt with. The following day general condition poor—blood-transfusion done (500 c. cm.). Immediate improvement. Further progress steady though slow. Evacuated to base on 4th day. Note received from base to the effect that patient had been evacuated to England in satisfactory condition after severe illness.

CASE X.—Lieut. V., admitted May 17, 1917, wounded 7 hours previously. Left leg and knee shattered, popliteal vessels torn, penetrating wounds left thigh, buttock, face. Radial pulse 120, but almost

imperceptible; face blanched. Anti-shock measures, but one hour later radial pulse imperceptible and blood-pressure below 40 mm. Hg. Death seemed imminent. Blood-transfusion (1100 c. cm.) done. Immediate improvement. After transfusion: pulse 130; blood-pressure, systolic, 120, diastolic 90. Half an hour later amputation above knee and other wounds dealt with. Apart from transient sepsis on the face of the stump, due to amputation having been carried through at the level of other wounds, progress was uneventful. Evacuated to base eight days later in very good condition.

CASE XI.—Sapper W. C., admitted May 18, 1917, in severe collapse; wounded seven hours previously. Had bled profusely from shattered left elbow and forearm. Blood-transfusion (1200 c. cm.) done immediately: marked improvement. Before transfusion: pulse 154; blood-pressure systolic 62, diastolic 0. After transfusion: pulse 130; blood-pressure systolic 110, diastolic 80. Seven hours later amputation above elbow. Two hours after operation: pulse 114; blood-pressure systolic 120, diastolic, 80. Further progress uneventful. To base in six days in good condition.

CASE XII.—Pte. J. J., admitted May 18, 1917, lower part of left leg blown away six hours previously. Patient collapsed and blanched. Blood-transfusion (900 c. cm.) done. Immediate improvement. Before transfusion: pulse 146; blood pressure systolic 74, diastolic 20. After transfusion: pulse 92. Half an hour later amputation below the knee. Seven hours after operation: pulse 118; blood-pressure systolic 128, diastolic 70. Further progress good. Evacuated to base in six days. Two weeks later a note from England stated "flaps fairly clean—slow progress."

CASE XIII.—Pte. W., admitted May 29, 1917, five hours after having sustained a severe comminuted fracture of the femur extending into the knee-joint. Condition of collapse. Blood-transfusion (1000 c. cm.) done. Immediate improvement in general condition and appearance. Before transfusion: pulse 120, blood-pressure 96. After transfusion: pulse 100, blood-pressure 110. Amputation above knee. Patient withstood operation well but died three days later of acute capillary bronchitis.

CASE XIV.—Pte. W. C. N., admitted June 1, 1917. Shattered right leg; was blanched and had bled profusely. Blood-transfusion (1060 c. cm.). Immediate improvement. Before transfusion: pulse 112; blood-pressure systolic 90, diastolic 32. After transfusion: pulse 76; blood-pressure systolic 134, diastolic 100. Half an hour later amputation above knee. The following day patient was in excellent condition and was evacuated to base.

CASE XV.—Driver L. H. B., admitted May 29, 1917, under the care of Captain S. J. Streight, C. A. M. C. Severe compound fracture right tibia and fibula into knee-joint, shattered right elbow and forearm, penetrating wounds of right thigh. Anti-shock measures instituted. Amputation above right knee and elbow, other wounds dealt with. Post-operative condition became progressively worse. Five hours after operation blood-transfusion (900 c. cm.) done. Before trans-

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fusion: pulse 136; blood-pressure systolic 86, diastolic 54. After transfusion: pulse 120; blood-pressure systolic 140, diastolic 74. Progress uneventful; evacuated to base on fourth day in good condition.

CASE XVI.—Second Lieut. M., admitted in severe shock and collapse, wounded seven hours previously. Left forearm shattered, penetrating wounds of right knee-joint, calf and foot, right ankle disorganized by large perforating wound, large dirty perforating wound left loin opening extra-peritoneal space. Condition quite inoperable. Anti-shock measures of little avail. Blood-transfusion (1100 c. cm.) done. Immediate improvement. Before transfusion: pulse 132; blood-pressure systolic 90, diastolic 32. After transfusion: pulse 140; blood-pressure systolic 120, diastolic 74. Four hours later under gas and oxygen amputation of left arm (gas gangrene), loin wound thoroughly excised, other wounds dressed. Following day amputation above right knee. Further progress uneventful. To base four days later. A note was received from the base stating that ten days later flaps were sutured, and three weeks after being wounded he was evacuated to England, "the wounds healing nicely and condition much improved."

CASE XVII.—Lieut. H., admitted in shocked condition, penetrating wound of abdomen, excessive amount of blood vomited. Laparotomy disclosed perforated stomach and active bleeding from severed gastro-epiploic artery, abdominal cavity full of bright blood. After operation: pulse almost gone, patient very blanched. Blood-transfusion (1000 c. cm.) done. Before transfusion: pulse 130; blood-pressure systolic 66, diastolic 0. After transfusion: pulse 92; blood-pressure systolic 170, diastolic 72. High systolic pressure due to injection of pituitrin given at the end of operation. During transfusion there was slight respiratory distress after 140 c. cm. of blood had been injected, but it was difficult to judge on account of the effects of the anæsthetic. Two hours later pulse became weaker and patient died in a few hours. At autopsy some hæmoglobinuria was evident. There is no doubt that a hæmolytic reaction due to the transfused blood hastened the death of this patient.

CASE XVIII.—L.-Cpl. A., admitted June 7, 1917, wounded the previous day, perforating wounds of both legs severing both posterior tibial arteries. Practically moribund condition—inoperable. Anti-shock measures carried out in resuscitation ward with little effect. Some hours later gas gangrene was evident in both legs, patient unconscious and pulseless. At this time it was thought that blood-transfusion followed by operation would give him his only chance. Blood-transfusion (1000 c. cm.) done. Response extraordinary. Breathing, which at first was shallow and sighing, became quiet and regular; pulse grew perceptible and though rapid was of good character. Color returned to his face, and half-way through the procedure he became conscious. At the end of the transfusion he was quite conscious and talked rationally. Half an hour later double amputation above knees was done under gas and oxygen, but patient died at end of operation. Had circumstances allowed of an earlier transfusion being done I feel sure that a successful result might have been expected.

CASE XIX.—Capt. A. C. T., admitted June 13, 1917, wounded five hours previously. There had been profuse hemorrhage from shattered leg. Pulse only 108, but of low tension. Immediate amputation for persistent bleeding from popliteal space. Post-operative condition progressively worse. Two hours later patient very collapsed and could be roused only with difficulty. Blood-transfusion (1100 c. cm.). Before transfusion: pulse 108; blood-pressure systolic 66, diastolic below 20. After transfusion: pulse 84; blood-pressure systolic 120, diastolic 66. Half-way through transfusion patient was quite conscious; at the end of the procedure he asked for a cigarette and smoked it with enjoyment. Further progress uneventful. To base in five days. Note from base stated "condition suitable for immediate transference to England."

CASE XX.—Gunner W., admitted June 18, 1917, six hours after being wounded. Left thigh almost completely blown away below middle. Condition of severe shock and collapse. Blood-transfusion (700 c. cm.) done. Immediate improvement. Before transfusion: pulse 130; blood-pressure systolic 80, diastolic 50. After transfusion: pulse 92; blood-pressure systolic 124, diastolic 78. Following this amputation was done, but patient withstood the operation badly and died ten hours later from shock.

CASE XXI.—Capt. G. S. T., admitted June 17, 1917, under the care of Capt. S. J. Streight, C. A. M. C., in collapsed condition. Right leg shattered, compound fracture right great trochanter, penetrating wound of arm. Blood-transfusion (1200 c. cm.) done. Before transfusion: pulse 134; blood-pressure systolic 70, diastolic 40. After transfusion: pulse 94; blood-pressure systolic 128, diastolic 80. Four hours later amputation below knee and other wounds dealt with. To base in four days. Later a note was received from the base stating that he had been evacuated to England in satisfactory condition.

CASE XXII.—Pte. F. McL., admitted July 4, 1917. Buried by a shell seven hours previously. Condition of shock and collapse from intra-abdominal injury and fracture of femur. Anti-shock measures for some hours produced slight improvement. Laparotomy done: abdomen full of bright blood and urine. Two-inch tear in bladder, lower part of spleen completely torn away, profuse spurting of blood from the remainder at the first touch. Splenectomy and bladder suture. Thomas splint to thigh. During operation pituitrin (1 c. cm.) was given, and saline (30 ounces) introduced into vein. At end of operation patient very blanched and pulse poor. Blood-transfusion (1000 c. cm.) done. Before transfusion: pulse 180; blood-pressure systolic 89, diastolic 40. After transfusion: pulse 140; blood-pressure systolic 185, diastolic 80. High systolic pressure evidently due to pituitrin, as seven hours later it had dropped to 136, diastolic being maintained at 80. Further progress uneventful. To base in two weeks. Four weeks after operation a note was received from the base stating that patient was in excellent condition and recovery was assured.

CASE XXIII.—Pte. G. G. H., admitted July 11, 1917, in severe collapse. Compound fracture of left leg, rupture of both tibial arteries,

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large wound of right leg with tear of posterior tibial artery. Had bled profusely. Anti-shock measures instituted—little improvement. Blood-transfusion (1000 c. cm.) done. Immediate improvement. Before transfusion: pulse 144; blood-pressure systolic 62, diastolic 40. After transfusion: pulse 96; blood-pressure systolic 126, diastolic 60. Several hours later amputation of left leg below knee, other wounds dealt with. Further progress uneventful. To base in four days in good condition. Note received from the base stated that he had been evacuated to England in good condition three weeks after being wounded.

CASE XXIV.—Pte. F. S., admitted in collapsed condition on July 12, 1917, seven hours after being wounded. Shell wounds left buttock, leg and foot, right popliteal artery severed, and severe fracture of femur involving right knee-joint. Anti-shock measures carried out with only temporary improvement. Four hours later blood-transfusion (1000 c. cm.). Before transfusion: pulse 156; blood-pressure 80. After transfusion: pulse 120; blood-pressure 136. Three hours later amputation above right knee, and other wounds dealt with, under gas-oxygen anæsthesia. Five hours after operation: pulse 128; blood-pressure 120. Further progress uneventful. Evacuated to base on fifth day in good condition with clean wounds and stump.

CASE XXV.—Dr. C. J. B., admitted in very grave condition under the care of Maj. G. E. Gask, D.S.O., R.A.M.C. (T). Penetrating wound of chest, tear of left femoral vein, penetrating wound of right knee-joint. After operation patient was blanched and collapsed; pulse was 130 and barely perceptible; blood-pressure 60 mm. Hg. Blood-transfusion was started, but before 60 c. cm. had been injected death was imminent. The patient's lips were bloodless, pulse imperceptible, breathing slow and jerky. Eighty c. cm. of very hot saline and 1 c. cm. pituitrin were now given intravenously, and the transfusion continued. When 400 c. cm. of blood had been injected the breathing had improved greatly. At the end of the transfusion (1200 c. cm.) the face was flushed, pulse strong, and patient was attempting to clear his throat. After transfusion: pulse 108; blood-pressure 144. Further progress uneventful—evacuated to base seven days later. Two weeks later word was received from the base that patient had been evacuated to England in good condition.

CASE XXVI.—Gunner E. G., admitted in very collapsed condition under the care of Maj. G. E. Gask, R.A.M.C. (T) on July 17, 1917. Severe penetrating wound of chest, extensive damage to lung. Had been wounded early that morning. Blood-transfusion (700 c. cm.) done. There was slight response, lasting a very short time. Death occurred some five hours later. Autopsy showed gas bacillus infection in hæmothorax and severe laceration of lung.

CASE XXVII.—Gnr. C. H. W., admitted on July 25, 1917, in collapsed and pulseless condition. Large penetrating wound of lower abdomen. Anti-shock measures were instituted and pulse returned—rate 96. Laparotomy eight hours after wound was received, resection 18 inches small gut suture of bladder and two tears in rectum. The

abdomen was filled with blood and clot; after operation patient was pulseless. Blood-transfusion (1100 c. cm.) was done, but patient was too far gone to benefit by it and died in less than three hours.

CASE XXVIII.—Lieut.-Col. R.A.M.C., aged fifty, was admitted in collapsed condition seven hours after being wounded, pulse almost imperceptible, face grayish-blue, condition inoperable. Severe compound fracture below right knee, penetrating wound right knee-joint, right hand blown off, left brachial artery severed, large perforating wounds left thigh. Blood-transfusion (1200 c. cm.) was done. Immediate improvement. Four hours later operation was carried out under light CHCl_3 anaesthesia, three surgeons being concentrated on the case; amputation above right knee, ligation of left brachial artery, excision of wounds of left thigh, amputation through right carpus. Further progress slow but good. Evacuated to base four days later; temperature 98, pulse 88. Two weeks later wounds reported to be improving.

CASE XXIX.—Second Lieut. A. D. J., admitted July 29, 1917, under care of Maj. G. E. Gask, R.A.M.C. Patient in collapsed condition, severe penetrating wound of chest from which there had been a large amount of bleeding. Condition inoperable. Blood-transfusion (740 c. cm.) carried out. After 100 c. cm. had been injected operation was begun. Thoracotomy, removal of shell fragments, irrigation of pleural cavity, closure of chest wall. Further progress good. Evacuated to base nine days later in good condition.

CASE XXX.—Pte. H. G., admitted on July 28, 1917, six hours after being wounded, in very collapsed condition. Right leg shattered and vessels torn, extensive wound of left calf with shell fragment embedded in muscles; pulse rapid and flickering, lips bluish-white. Blood-transfusion (1200 c. cm.). Two hours later amputation above right knee (for gas-gangrene), left calf widely opened up. Next morning patient was very much improved, but by evening gas-gangrene of left leg was present and amputation above left knee was done under gas-oxygen anaesthesia. The following day there was persistent vomiting (acidosis), which was relieved by an intravenous injection of 20 ounces of five per cent. soda bicarbonate solution. Further progress uneventful. Evacuated to base five days after admission in very good condition, both thigh stumps clean.

CASE XXXI.—Gnr. W. P., admitted on August 4, 1917, in collapsed condition. Right forearm shattered, compound fracture right femur with severing of popliteal vessels. Anti-shock measures carried out but only slight improvement resulted. Blood-transfusion (1000 c. cm.) done with immediate and marked improvement. Amputation through forearm and thigh now done. Patient withstood operation well, but died in 36 hours from extensive gas-gangrene of right thigh.

CASE XXXII.—Pte. D. O'L., admitted on August 5, 1917, in very collapsed condition. Forty-eight hours previously had sustained a large wound in left thigh and while lying out in a shell-hole had received a second and extensive wound in the left calf, twenty-four hours later.

There had been severe hemorrhage from the latter. Anti-shock measures were instituted, but with only slight improvement. Blood-transfusion (1100 c. cm.) done. Immediate improvement resulted. Before transfusion: pulse 132; blood-pressure 90. After transfusion: pulse 96; blood-pressure 142. One hour later operation was done. Further progress good—evacuated to the base in two days in very good condition. It is interesting to note that at the end of the transfusion there was a marked urticarial eruption (serum rash?) over the trunk and extremities. It had subsided in less than 24 hours.

CASE XXXIII.—Lieut. J. K. P., admitted on August 5, 1917, under the care of Capt. W. Beggs, C.A.M.C., in very poor condition, 24 hours after sustaining a severe compound fracture of left leg into knee-joint with damage to vessels. After anti-shock measures, drainage established and bleeding controlled. The next day pulse was very rapid, face still blanched, leg becoming swollen. Blood-transfusion (530 c. cm.) done. Before transfusion: pulse 178; after transfusion: pulse 132. Amputation above knee. Further progress uneventful. Evacuated to base on August 9 in good condition; pulse 90.

CASE XXXIV.—Pte. J. W., admitted on August 10, 1917. Wounded 12 hours before: extensive comminution of right femur, anterior muscles blown away but hamstrings intact, femoral vessels torn. Condition of profound collapse. Anti-shock measures instituted on admission with very little effect. Blood-transfusion (1000 c. cm.) two hours later. Before transfusion: pulse 152; blood-pressure 72. After transfusion: pulse 130; blood-pressure 146. Patient suffering from toxæmia due to gangrenous condition of muscles. High amputation done one hour after transfusion, but intramuscular planes found to be extensively infected up to groin. Death 20 hours later.

CASE XXXV.—L.-Cpl. L. H., admitted on morning of August 11, 1917, had been wounded the previous evening. Right leg shattered, involving knee-joint, part of right tarsus blown away. Anti-shock measures for several hours with no effect. Blood-transfusion (700 c. cm.) done. Before transfusion: pulse 152; blood-pressure systolic 60, diastolic 0. After transfusion: pulse 114; blood-pressure systolic 120, diastolic 60. Amputation above right knee. Further progress uneventful. Evacuated to base in good condition on fourth day.

CASE XXXVI.—Pte. A. H. C., admitted August 11, 1917, collapsed and almost pulseless; had bled profusely from gaping wound in right popliteal space. Anti-shock measures had very little effect. Blood-transfusion (1000 c. cm.) done. Immediate improvement. Before transfusion: pulse 124; blood-pressure systolic 74, diastolic 15. After transfusion: pulse 110; blood-pressure systolic 142, diastolic 68. Amputation above wound two hours later under gas-oxygen anæsthesia. Examination of amputated leg showed complete division of popliteal vein and large tear in popliteal artery. Further progress uneventful. Evacuated to base in good condition on fourth day.

In reviewing these cases of primary hemorrhage I feel that better results might have been obtained in cases 1, 7 and 18. In case 1 the fatal issue was due to the early development of gas-gangrene which might have

been eliminated by amputation had the transfusion been done earlier. In case 7 an earlier transfusion would have permitted earlier amputation which would have rendered less liable the development of gas-gangrene. Though the infection in this case was controlled, it was responsible apparently for thrombosis in the femoral vein with subsequent death from pulmonary embolism. Case 18 was seen during the rush of the Messines battle. Measures to counteract shock were carried out in the resuscitation ward but were unsuccessful. Although the blood-transfusion produced a startling improvement his toxæmia was too intense to allow him to withstand the anæsthetic and the shock of the operation.

CONCLUSIONS

1. Many cases admitted in an inoperable condition from severe hemorrhage have been rendered operable by blood-transfusion.

2. The largest factor in the causation of the shocked condition as seen in patients admitted to a casualty clearing station appears to be the loss of blood, except in case of visceral injury.

3. In two cases hæmolysis hastened the death of the patient—in one of these the citrate method was used. The possibility of hæmolysis certainly is present, but the danger of its occurrence is slight in comparison with the danger of operating on a shocked and exsanguinated patient.

4. The results in this series of cases of severe primary hemorrhage may be classified as: Life saving, 22; immediately beneficial but died from infection or operation, 9; no benefit, 3; harmful, 2; total, 36.

5. Although the mortality in this series of cases is comparatively high it must be remembered that all the patients were in a desperate condition, and with perhaps one possible exception could not have been expected to survive if the procedure had been withheld.

NOTE BY COL. C. GORDON WATSON

During the past year I have had the opportunity of observing the technic and the results of blood transfusion by Major Bruce Robertson and other workers. Without doubt transfusion of blood after primary hemorrhage is a life-saving device of the greatest value and enables urgent operations to be successfully performed under conditions otherwise hopeless. In the past blood transfusion has failed to come to the fore owing to technical difficulties. The stimulus of war and the urgent need for blood transfusion has resulted in greater familiarity with the technic.

For many years past we have in England, at any rate, trusted to saline infusion to restore the balance after hemorrhage. So far as my experience goes, there is no comparison between the results of blood transfusion and saline infusion. The effects of blood transfusion are instantaneous and usually lasting; the effects of saline too often transitory—a flash in the pan—followed by greater collapse than before. In civil practice, speaking generally, the occasions for transfusion are few; in military practice, in the

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forward line, the exsanguined wounded man is a regular habitué of the reception room. The problems of shock and collapse are receiving every day greater attention.

In every casualty clearing station there is a resuscitation ward with hot beds, heated by hot air or electric light, with arrangements for giving hypertonic intravenous infusions, etc. Here we endeavor to estimate the shock of battle, the shock that follows trauma in loss of blood, or the shock of toxæmia, to assess the proportionate damages to each and to apply the appropriate remedy.

The methods of blood transfusion employed in the casualty clearing stations vary with the individual taste of the surgeon. Major Robertson has acquired great dexterity with the syringe method and his results are correspondingly good. Practice in team work is essential to success and the two surgeons and the syringe orderly must drill together. Record syringes can be relied on for the purpose: others cannot. The scope of blood transfusion is not limited to primary hemorrhage. It is of undoubted value for secondary hemorrhage and we have used it successfully also in two severe cases of CO poisoning (as a sequel to venesection). In the selection of a donor for blood transfusion certain precautions should be taken when the circumstances of the case permit. At the front, particularly during the periods of heavy fighting, time does not permit of tests to eliminate syphilitic taint nor indeed to ascertain if the blood of the donor is incompatible with that of the patient. Such risk as there is must be run if the urgent need of the patient is to be promptly met.

I have more than once seen alarming symptoms arise during transfusion. In one case the pupils dilated, the eyes were turned up, the pulse rate increased and the patient became pallid and unconscious and died the same day. At the autopsy the blood was completely hæmolyzed. The condition of the wounds, however, showed that the chances of recovery were remote. In other instances I have noted transitory respiratory distress, sweating and præcordial pain followed subsequently by a varying amount of hæmoglobinuria. The occurrence of rigors with a transitory rise of temperature is by no means uncommon after transfusion and is not an indication of incompatibility of bloods. Too rapid transfusion may be followed by acute dilatation of the heart when the myocardium is exhausted and weakened by hemorrhage and shock. As Crile has pointed out, the work of the heart increases in geometric ratio to the volume of blood, and it is easy to realize the risk involved in suddenly producing a rapid increase in the volume of blood when the heart is already tired out. I have seen this exemplified in one case.

I feel confident that blood transfusion has come to stay and that under the stimulus of war, and the mass of material that war provides, our methods will steadily improve. The excellent result which Major Robertson has secured will, I hope, stimulate other surgeons to increased activity in the practice of this life-saving device.

THE USE OF DICHLORAMINE-T IN THE TREATMENT OF INFECTIONS AND INFECTED WOUNDS*

BY LIEUTENANT WALTER E. LEE, M.R.C.

AND

CAPTAIN WILLIAM P. FURNESS, M.R.C.

THE experience of nearly two and a half years at the hospital of the American Ambulance in Paris has been in accord with that of the majority of surgeons who have served in the present war, namely, that the chlorine preparations have proven in our hands superior to all other germicidal agents. It was soon found, however, that all of the standard hypochlorite preparations, as eau de Javelle, Labarraque's and the eusol solutions, were very irritating to the skin if used for any length of time. In order to minimize this irritation, various modifications of the original formulæ were tried, the most successful of which was that of Dakin, a very dilute, neutral, Labarraque's solution. This neutral hypochlorite solution was found to have three inherent faults.

First: The neutral solution, unlike the original Labarraque's with its free alkali, was very unstable and it was necessary to prepare it almost daily.

Second: The dilute 0.48 per cent. solution contained such a very small mass of germicide, if the concentration was even slightly lowered, *e.g.*, to 0.4 per cent., the germicidal efficiency was very materially impaired, that it was necessary, in order to obtain a maximum effect, to have the solution all times in contact with the surface of the wound.

Third: The active chlorine was used up so rapidly from the solution when it came in contact with the wound exudate, from seven to fifteen minutes as estimated by Carrel, that it was necessary to frequently renew the supply of germicide, at least every two hours night and day.

Carrel, Dehelly and Depage gradually overcame all these inherent faults of the weak neutral hypochlorite solutions of Dakin and Daufresne by developing a beautiful but complicated technic for their application. And with this technic they were able to obtain wonderful results in the treatment of infected wounds.

It is generally conceded that they have demonstrated conclusively:

First: That if infected wounds are treated with the same aseptic surgical care that surgeons give to clean wounds, very unusual results can be obtained.

Second: That the primary dressing of infections and infected wounds should be made a formal aseptic operation in which all devitalized and infected tissue should be removed, with knife, forceps and scissors, that it is mechanically practical and anatomically justifiable to sacrifice.

Third: That infected wounds so treated can be sterilized if the wound surfaces are constantly bathed with even such a small mass of germicide as is contained in the aqueous hypochlorite solutions. This constant immersion

* Read before the Philadelphia Academy of Surgery, October 1, 1917.

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can be accomplished by Carrel's complicated hydraulic system of reservoirs and tubes.

Fourth: That when the wound surfaces are practically clean, one bacterium per five microscopic fields on three successive counts made every third day, the wound edges may be approximated by sutures and union may be expected to take place without infection in about 80 per cent. of the cases.

Many have had the privilege of seeing the work of Carrel and Depage and can personally testify to the accuracy of their claims, but the indifferent success most of us have had in trying to obtain similar results, Carrel himself says, is because of our failure to grasp and apply the details of the technic. The Carrel technic demands an unusual degree of painstaking and time-consuming care, not peculiar skill, upon the part of the surgeons, nurses and chemist, and the unusual expense for both the apparatus and dressing material develops difficult problems for the entire personnel of even our civil hospitals.

Now it is essential in this technic of Carrel to so prepare the wounds at the primary operation that they will act as basins for retaining the hypochlorite solution during the period of repair. Thus the cardinal principle of surgery, dependent drainage of infected cavities, must be abandoned if this treatment is to be used. In spite of this, if the wounds are subsequently treated with the aqueous hypochlorites with the infinite care Carrel practises, the results will be far better than with any other treatment we have used in the past. But, if for any reason this perfect hydraulic system breaks down, and it is very vulnerable, these wounds prepared in this way act as pus pockets, and, as has been expressed by many military and civil surgeons, such wounds give unfortunate results.

We must not forget in our admiration for the Carrel technic, that it was because of the severe skin irritation produced by the standard hypochlorite preparations that Dakin first suggested his modified Labarraque's solution; and that because of the inherent faults of this Dakin's solution, instability, the very small mass of germicide contained, and the rapidity with which it liberated its chlorine, it was necessary to develop an unusual technic to make such a solution effective in the treatment of infected wounds.

Or this might be stated in another way, that the Dakin's solution and Carrel technic represent an effort to modify Labarraque's solution and the method of its application to infected wounds in such a way that there will be a minimum of the dreaded skin irritation produced by the original Labarraque's formula.

These facts were soon realized by Dakin, and he started a new search for a more effective germicide. If possible a chlorine compound which would be non-toxic and non-irritating to both the surface of the wound and to the skin and which could be placed in contact with the infection in a menstruum that would be capable of containing not only the desired mass of germicide, but also of holding in solution a reserve mass over a long period of time.

In these investigations, he found that the various hypochlorite prepara-

tions used in the treatment of infected wounds react with proteins of any kind, and one of the first reactions consists in the amido-groups uniting with the active chlorine to form substances containing the NCl group.

These products, which belong to the group of chloramines, possess marked bactericidal properties, and are the active germicidal agents produced by the hypochlorites when they come in contact with the wound exudate. These chloramines are non-irritating to animal cells and this explains the absence of irritation in the wounds where the irritating active chlorine of the hypochlorite has been changed into chloramines and other non-irritating protein derivatives.

It is quite simple to produce many of these chloramines synthetically. The first one to be used was in the form of a sodium salt of toluene-para-sulphon-chloramide or Chloramine-T and sold in this country under the trade name of chlorazene. This synthetic chloramine was non-irritating to the skin and could be used in aqueous solutions in 2 to 4 per cent. strengths, but it had the same fault as the aqueous hypochlorite in that its active chlorine is liberated very rapidly, and though the difficulty of the skin irritation was obviated, it was still necessary to frequently renew the solution as with the aqueous hypochlorites.

Dr. Dakin entrusted to us the honor of testing the surgical value of another synthetic chloramine at the Pennsylvania Hospital, toluene-para-sulphon-dichloramine, which he called Dichloramine-T. This preparation was dissolved in chlorinated eucalyptol and could be used in strengths varying from 5 to 20 per cent. By using oil as a menstruum a large mass of germicide was brought to the infection and yet held so firmly in solution that it very slowly diffused into the surrounding medium for at least as long as eighteen to twenty-four hours, and during this period a mass of germicide was at all times active, which was equal to that given off during the first seven to fifteen minutes by the hypochlorite solution.

Theoretically then, this new chlorine compound eliminated at the start the chief indication or necessity for the Carrel technic, skin irritation. With such a solution, it should be possible to present to an infection an overwhelming mass of germicide, a 20 per cent. solution of dichloramine being approximately 80 times the germicidal mass of a 0.48 per cent. hypochlorite solution. There is a vital necessity, when using germicides in the treatment of infections, for the earliest possible application of an overwhelming mass of a rapidly acting agent, because infection develops in the tissues at the rate of a geometric progression and not by the slow process of addition, and therefore every minute counts in the end result. Dichloramine, with a phenol oil coefficient of about 50, can be presented in a larger mass without injury to the tissue cells than any other germicide we have used. Instead of having this chlorine given up with explosive rapidity and the consequent necessity of frequent renewals of the solution, it would be slowly diffused into the surrounding media, making it unnecessary to renew the solution or to dress the wounds more frequently than once in every twenty-four hours.

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Five months have elapsed since the writing of the first report upon the use of Dichloramine-T in the treatment of infections and infected wounds. We have now the records of 6028 civil cases in which the germicide has been used and of four months' work and 1200 cases reported by Captain Joshua Sweet with war wounds in the U. S. Base Hospital No. 10 in France. From this clinical experience the conclusions tentatively offered in our first report have developed into firm convictions.

Three thousand three hundred and eleven cases are reported by Dr. Robert P. Cummins from the surgical dispensary of the Midvale Steel Works.

Two thousand two hundred and seventy-one cases reported from the Pennsylvania Hospital from the surgical services of Dr. Robert G. LeConte, Francis T. Stewart and Walter E. Lee, and of the work of Dr. Robert C. McIver.

Two hundred and seven from the Germantown Hospital in the service of Dr. Walter E. Lee and the work of Dr. Robert Kelly and Dr. Robert Regester.

One hundred cases from the St. Agnes Hospital by Dr. G. M. Dorrance.

Fifty cases from the Children's Hospital in the service of Dr. Walter E. Lee and by Dr. Edgar Christy.

Eighty-nine cases from the Jefferson, Lankenau and Episcopal Hospitals.

From the records of 3311 cases at the Midvale Steel Works, it has been possible to make a comparison between the efficiency of tincture of iodine and Dichloramine-T. A period of four and a half months in 1916, when iodine was exclusively used, was compared with the same period of time in 1917 when Dichloramine-T was used. The results with Dichloramine-T were 60 per cent. better than with iodine.

An interesting comparative study was made at the Pennsylvania Hospital between the Carrel technic and Dakin solution and Dichloramine-T applied with the technic to be demonstrated on the screen. With the working factors as nearly the same as it is possible to have them, same surgeon, nurses and surgical asepsis and the same class of injuries, a total of 157 industrial injuries were treated by the Carrel technic and Dakin's hypochlorite solution with an average healing time of 14.4 days. The succeeding three months Dichloramine-T with a simplified technic was used in the treatment of 281 cases with an average healing time of 10.4 days.

At the Pennsylvania, Germantown and Children's Hospitals, there have been 2528 cases under our direct personal supervision. In the 825 cases of infection there was but one case in which a localized process was not controlled and in which there was a secondary involvement of tendon, bone or joint. In this group there were 60 cases of bone infection, and yet in no instance was it necessary to amputate because of infection. There is no doubt that the period required for healing has been considerably less than that with any other germicide we have used.

There has been a total of 1651 lacerated and infected wounds. When mechanically possible, we have routinely closed these wounds by suture up

to six hours after the receipt of the injury, and frequently as late as twelve hours and always without drainage. The wound surfaces have been covered with a 20 per cent. solution of the oil before the sutures were inserted. Over 75 per cent. of the cases have healed without clinical signs of infections.

There have been 30 cases of extensive burns. The unusual comfort to the patient, together with the simplicity of the dressing, appeals to the patient and surgeon. The time required for healing has been decidedly less than required by any other means employed, and the resulting scars are soft and pliable, and very much better than obtained by us with ambrine.

With Dichloramine-T we have been able to obtain as good results as we have ever had when using the Dakin hypochlorite solutions with the complicated technic of Carrel. In addition, we have found:

1. That skin irritation will not occur if the wounds are not covered with thick occlusive dressings. This means the use of the smallest possible amount of gauze dressing and bandage.

2. The small amount of exudate from wounds treated with Dichloramine, makes it practical to use these thin dressings, and in our dispensary, at the Pennsylvania Hospital, there has been a saving of 75 per cent. of the gauze and bandages formerly used. Further, a still greater saving in dressing material and time results from the decrease in the number of dressings required for each wound during the period of healing. Rarely is it necessary to dress a wound, even during the first few days, more frequently than once in every twenty-four hours, and after that, intervals of forty-eight and seventy-two hours are usual.

3. Dichloramine, unlike the aqueous hypochlorite solution, has no effect upon the knots of catgut ligatures, and no disintegrating effect upon the catgut itself. The occurrence of secondary hemorrhages in wounds treated by the Carrel method was not uncommon in our experience at the American Ambulance. Captain Sweet reports that, in his 1200 cases of major infected military wounds, there was not one secondary hemorrhage.

4. Too great stress cannot be laid upon the value of Dichloramine as a deodorant dressing. The absence of the usual disagreeable odors in our wards, containing cases with fecal fistulae, is a general observation. During the last two months, it has been used routinely in the wards of the Oncological Hospital in Philadelphia. Where formerly these putrid, sloughing, malignant tissues were irrigated every two hours with all kinds of solutions, with indifferent success in the control of infection and with a persistence of the offensive odor, now they are packed lightly every six hours with gauze saturated with a 5 per cent. solution of Dichloramine-T. Not only has the odor disappeared entirely, but the wound infections have been controlled.

That there may be no misunderstanding of our position as to the value of germicides in the treatment of infections and infected wounds, we wish to repeat the concluding statement of our first report. "One should not depend upon a chemical agent to perform, in the treatment of suppurating wounds, that which can and should be done quickly and thoroughly by mechanical

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means. Neither chemistry nor bacteriology can, or should be expected to replace the mechanics of surgery. At the best, these chemical germicides can react only on the bacteria with which they come in contact, which means a very superficial process. Therefore, at the primary operation all foci of infection and all devitalized tissue must be removed when possible, by surgical procedures."

We wish to present in detail the methods used and results obtained in the treatment of infections and infected wounds in the Pennsylvania, Germantown and Children's Hospitals during the last five months—a total of 2213.

Accepting the results of the work of Carrel at Compeigne and Depage at LePan as demonstrating conclusively that infections and infected wounds must be treated with the same surgical asepsis as one follows in the care of sterile wounds, we have tried to consistently make of the primary dressing a formal aseptic operation, with the wearing of sterile gloves and the handling of the tissue with sterile instruments only. We continue this aseptic care of the wound during the entire period of treatment.

In the *preparation of the skin*, soap and water were first used for cleansing, care being taken to plug the wound with sterile oil soaked gauze. Of late we have found that the use of benzine for cleansing the skin is to be decidedly preferred. Neither water, alcohol nor hydrogen peroxide should be used, as they decompose Dichloramine-T.

In *infections* the focus has been excised when mechanically practical, but it has always been widely exposed so that the germicide may have an opportunity for a complete chemical contact with the bacteria. Adequate drainage has always been provided according to accepted surgical principles. After the completion of the mechanical procedures, the wound surfaces are thoroughly covered with the 20 per cent. solution of Dichloramine-T and then the wound edges are held apart by a generous gauze pack saturated with the same strength of oil. A very light gauze dressing is then applied, not more than four layers. If a bed patient, a clothing cradle is placed over the area to avoid displacement of the dressing, which may be held in place by a few strips of adhesive or a towel and safety pins. If the patient be ambulatory, the fewest possible turns of a lightly applied gauze bandage may be used to keep the dressing in place. Care is always taken in applying dressings not to make them impervious, for the solvent, eucalyptol oil, is an essential oil and acts like all essential oils when confined by air-tight dressings. If the discharge is unusual in quantity fresh gauze may be re-applied during the day, but in our experience it is rarely necessary to renew the dressing. The oil should be applied but once in every twenty-four hours. At the first dressing after the operation (and at all subsequent dressings) the same aseptic surgical technic is employed as at the time of the operation; and at this time, primary gauze drainage should be removed and no more re-inserted unless the walls of the cavity or sinus collapse in such a way as to make it impossible to introduce the oil. A 5 per cent.

solution of the oil is all that is required for secondary dressings with the possible exception of massive infections as in carbuncles or extensive bone lesions. Of course an opening in the surface of the wound must be maintained for the introduction of the oil until the infection is controlled. Of the 111 felons treated, it has never been necessary to remove bone or to amputate. During this same period, there have been 37 palmar abscesses and in no case has there been a spread of the infection to the forearm. In this group of 825 cases, amputation because of infection has never been required.

Our first use of the Dichloramine-T for *intra-abdominal infection* was limited to old, well walled-off sinuses following appendicial and tubal abscesses. The unusual rapidity with which these infections were controlled and the absence of any untoward symptoms gave to us the necessary confidence and we now use it routinely at the time of operation in intra-abdominal abscesses in exactly the same manner as described with superficial infections. There have been 13 cases of gangrenous, perforated appendicitis with abscess. Upon the removal of the appendix, the 20 per cent. solution has been dropped over all the visibly infected tissue. A medium sized gauze drain, saturated with the same strength of oil, has then been placed in the cavity and the wound closed in the usual way. The following daily dressings consist in applying 2 or 3 c.c. of the same strength of oil to the gauze wick and upon the edges of the wound. About the fourth day, the drain is loosened and removed when it has separated from the walls of the sinus. This is usually between the third and the seventh day. The cavity is then gently dried by means of gauze or cotton pledgets, and then filled with 5 per cent. oil. It has been our experience that it is rarely necessary to replace gauze drainage after the removal of the primary wick, but of course this may be necessary if the walls of the sinus collapse because of inadequate adhesions. The cavity of the wound is usually filled each day with the 5 per cent. oil until it closes by granulation from the bottom. In none of these cases have there been any unfavorable symptoms; and the average time of complete closure has been 15 days. There have been 9 cases of pelvic abscess of tube ovarian origin in which the oil was applied at the time of operation. Here again there have been no complications and the average time of closing of the wound has been 18 days.

There have been 30 cases of burns. In the treatment of burns it was possible from the start to control the infection with 5 per cent. solution of oil; but the sticky exudate resulting so infiltrated the gauze, that the dressing became adherent and impervious; and a layer of purulent fluid would collect beneath the dressing as with ambrine. We now employ one layer of a wide-meshed paraffined gauze, which is placed over the burned surface and then the oil is sprayed upon this film of paraffined gauze. The open mesh allows the oil to come in contact with the wound surface and also for the wound exudate to escape. No other dressing should be applied and the usual technic of the open-air treatment of burns should be followed.

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Depending upon the amount of exudate, the paraffined dressing can be painlessly removed daily or less frequently as required.

For the preparation of an open-meshed gauze to be used in the treatment of burns we have found the following method of preparation the most satisfactory:

Ordinary mosquito netting of good quality with a mesh of about one thirty-second inch is cut in strips on the thread six inches wide and one yard long. It has a small amount of starch or stiffening in it which it is not necessary to wash out, in fact it can be handled and rolled more easily if this starch is not removed.

The ambrine, parawax, redintol J. & J. or cerelene, or similar preparation is melted on a water-bath in a flat tray and brought to the boiling point. When it is thoroughly melted one end of the strip of mosquito netting is folded over a glass rod as in starting a roller bandage. This is dipped in the melted wax and with the tips of the fingers protected by rubber gloves grasping the ends of the glass rod it is rolled up, letting the strip of mosquito net run through the melted wax as it is pulled towards the roll and the roll is wound up slowly as it rests on the bottom of the pan. When the strip is all rolled up, continue turning the roll over and over in the melted wax until it is thoroughly soaked, then quickly stand it on end in the pan of hot melted wax. The wax on the gauze quickly drains out of the meshes as it remains in the heat; the little excess that remains on the end of the roll can be shaken off. Allow the roll to cool slowly by standing it on end. Store in a sterile muslin container.

We have tested several combinations of paraffine and petrolatum, paraffine and liquid petrol, paraffine and beeswax, and plain beeswax—as to their solubility by Dichloramine-T in eucalyptol oil. In all combinations where petrolatum or liquid petrol or beeswax was used to make the paraffine flexible, these substances were dissolved out of the wax and made the dressing soft and rendered the paraffine thin and friable on the gauze. Pure paraffine, redintol and cerelene were unaffected by prolonged soaking in Dichloramine.

Wounds.—(a) *Incised Wounds.*—Employing the same aseptic technic previously described, all bleeding vessels are ligated with catgut; the wound surfaces covered with the 20 per cent. solution of oil and then the edges closed with sutures and without drainage. We strongly advise against the use of drainage of any kind in the primary suture of wounds; it is unnecessary when employing Dichloramine-T and always provides a definite focus of infection. Dichloramine-T does not affect the tensile strength or the holding of the knots of catgut after an exposure of more than three weeks, so that the danger of secondary hemorrhage from the slipping or premature absorption of ligatures can be disregarded. The capillary ooze in the presence of Dichloramine-T and eucalyptol oil is decidedly less than with any other germicide we have used; and there will be no more oozing than the tissues are normally able to care for, while you have placed in the tissues a mass of germicide that makes infection very improbable. Thus the two

indications for draining incised wounds, hemorrhage and infection, are almost entirely eliminated when Dichloramine-T is used. In the subsequent dressings, the surfaces and wound edges may be sprayed daily, or even less frequently, with a 5 per cent. solution of oil until the wound is dry. If infections develop, it is only necessary to remove one or two stitches, to obtain a small opening through which the solution may be introduced into the depths of the wound. For us, the simplest method has consisted in the introduction of a grooved director through such an opening, to the bottom of the wound; and then when the coarse spray of an atomizer is directed against the groove, the oil flows into the wound. This also may be done with a glass hypodermic syringe and needle. It has been our experience that infection has been controlled on an average of $5\frac{1}{2}$ days, when developing after the primary suture of incised wounds.

Wounds.—(b) Lacerated Wounds.—After the usual preparation of the skin, all the devitalized tissue is removed with a knife, scissors and forceps, that it is mechanically practical to take away; and in a like manner all foreign bodies and splinters of bone (if they be detached from the periosteum). If the primary operation takes place within three hours after the injury, the wound should be closed by suture after thoroughly covering the wound's surfaces with the 20 per cent. solution of the oil without drainage. When infection subsequently develops the previously described technic is followed, just enough of the stitches being removed to allow the introduction of the oil to the focus of the infection.

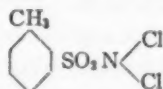
Wounds.—(c) Crushed.—When these involve the hands and feet, the treatment and results are not very different from the lacerated wounds. The time of healing, of course, is increased, tendons require more time than subcutaneous tissues; bone more than tendons; while the longest time required for healing is when there is joint involvement. We have had 10 compound fractures of the leg but none of the thigh. The treatment of these compound fractures, when involving these small bones, should be along the same lines described in the care of lacerated wounds. We have successfully closed one compound fracture of the tibia and fibula on the seventh day; and we have successfully closed a large compound fracture of the tibia and fibula with a 5-inch wound in the overlying soft tissue by primary suture six hours after the accident occurred. The question of secondary suture, which has not entered into the problem of the care of the incised, punctured, perforated and lacerated wounds, because of the rapidity with which they have closed of themselves, of course, enters into the problem of the care of the massive wounds, as compound fractures of the long bones. Our study of the bacterial counts of the wound has demonstrated that it is possible to bring the count to the point of clinical sterility, one bacterium per five microscopic fields, for three successive days, just as promptly as with hypochlorite.

Wounds.—(d) Massive.—In which it is mechanically impossible or surgically undesirable to close by sutures. Here the primary operation in no way differs from that of the treatment of lacerated wounds, except in

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degree. In these wounds the question of dependent drainage is always to be considered, and provided, if surgically indicated. At the completion of the operation the surfaces of the wound are thoroughly covered with a 20 per cent. solution of oil and then wide-meshed paraffined gauze strips are placed directly in contact with the raw surfaces of the wounds to make the subsequent removal of the dressings painless. Over the paraffined gauze not more than 4 layers of gauze should be placed.

Dichloramine-T is prepared from toluol by a series of chemical reactions which lead to a substance having the following structural formula:



Its use as a disinfectant is dependent almost wholly on the reactions of the NCl_2 group in the side chain. In this group the chlorine (Cl) is very loosely held and is given off whenever the substance comes in contact with any other material having an affinity for chlorine. When detached from this compound chlorine it is in the free or nascent state and exerts all of its characteristic elementary reactions.

Free chlorine unites with nearly all common substances and materials to form chlorine compounds which are as a rule less stable than those substances from which they came. The well known action of bleaching powder depends upon this fact. It is the chlorine in the bleach which attacks the colored substances in cloth, forming chlorine compounds with them. These chlorine compounds are subsequently destroyed by the oxygen of the air or other agencies. The union of chlorine with other substances is greatly hastened by the presence of water or the moisture of the air, by the action of light, particularly direct sunlight, and by heat.

To return to Dichloramine-T; this substance is almost insoluble in water. It is soluble in a considerable number of organic solvents and oils. It is soluble, for example, in benzol, chloroform, carbon tetrachloride, alcohol and acetone. It is soluble in many essential oils, eucalyptol among them. Those solutions in which the solvent cannot be attacked by chlorine are stable. The compound carbon tetrachloride contains all the chlorine it is capable of taking up—it is saturated with chlorine, and therefore Dichloramine-T in such solution is stable. Alcohol on the other hand is broken down by free chlorine, it rapidly abstracts chlorine from the Dichloramine-T and is itself changed to other substances and the alcoholic solution of Dichloramine-T keeps but a very short time.

For the purpose of applying it to wounds the Dichloramine-T must be in solution. Carbon tetrachloride or chloroform would be good solvents because of the stability of the solutions, but are not suitable to apply to living tissues in quantity for a long time. Eucalyptol has been chosen after a very careful search as the best available solvent to use for the application of Dichloramine to the tissues.

Eucalyptol has, however, an affinity for chlorine such that it quickly

breaks down the Dichloramine-T. This makes it impossible to use it directly. Eucalyptol can be first treated with chlorine and its affinities are thus partly saturated. This chlorinated eucalyptol is a good solvent for Dichloramine-T. Its chlorine affinities cannot be completely satisfied, however, and the stability of the solution is far from perfect. Dissolved in chlorinated eucalyptol, Dichloramine-T is slowly broken down, that is, the chlorine is given off and the toluol-sulphon-amid (an intermediate product between toluol and Dichloramine-T) is left. This substance crystallizes out. The chlorine given off is partly set free into the air and partly acts further on the eucalyptol to produce irritating volatile products. The decomposed solutions frequently cause much irritating pain when applied to wounds.

The breaking up of Dichloramine-T in chlorinated eucalyptol is hastened by the presence of water, alcohol, or anything else that has an affinity for chlorine. The chlorinated eucalyptol is capable of taking up a certain amount of water from the air. The breakdown is hastened by the action of light and by any rise in temperature.

For the foregoing reasons particular attention must be paid to the following points in handling Dichloramine-T and its solutions:

1. All bottles should be of a dark amber, glass stoppered. They should be thoroughly cleaned and dried before any of the materials are put in. If alcohol is used for drying the bottles, it should be allowed to completely evaporate before the bottles are used.

2. No solutions should be returned to the stock bottles from the ward bottles or atomizers at any time.

3. Bottles in which the solution has already undergone decomposition should be very carefully cleaned with hot water and then dried thoroughly before being used again.

4. If, in using the 20 per cent. solution, medicine droppers or glass rods are used to transfer the oil to the wound surfaces the droppers should be dry if put into the oil bottles. The common practice in some places has been to boil these utensils to sterilize them and then to use them while still wet. This results in the gradual accumulation of water in the stock bottles and a very rapid decomposition of the Dichloramine-T. The glass rods or pipettes or syringes if left in contact with the oil for five or ten minutes are entirely sterilized and do not need boiling. The method we have followed is to pour the required amount for the wound into a clean dry medicine glass and to take the oil with the pipette from this second container.

If these precautions are faithfully observed, no trouble from the decomposition of the solution will be encountered. We have repeatedly kept the 20 per cent. solution on the laboratory desk in brown bottles for three to four weeks before it decomposed.

BIRTH INJURIES OF THE SHOULDER*

By ASTLEY P. C. ASHHURST, M.D.

OF PHILADELPHIA

THE clinical entity known as brachial birth palsy has been the subject of a number of rather controversial papers in recent years. These controversies have had to do both with the pathogenesis of the affection and with its treatment. The present contribution to this discussion is based on a careful study of about forty patients seen within the last few years in my services at the Episcopal and Orthopædic Hospitals, and is an effort to systematize the treatment of a condition still too frequently overlooked by the average practitioner, or, even if not overlooked, too often neglected. It is difficult to systematize the treatment of an affection whose pathogenesis is not known; but in spite of much study I must confess that my views on the latter subject are still uncrystallized. But I know that much good may be accomplished by definite lines of treatment and much harm done by neglect or by misdirected efforts. This is, in fact, one of those departments of surgery in which Science still lags behind Art; but as experience accumulates there is every reason to believe that Art, like Wisdom, will be justified of her children.

First brought prominently before the profession in 1872 by Duchenne, it was an affection long regarded as of interest solely to neurologists, owing to the prevalent theory as to its causation: Duchenne taught that the lesion was in the brachial plexus, but as his observations are recorded in a text-book devoted to Local Electric Treatment he did not enter into the question of exact anatomical localization of the lesions. Erb, in 1874, studied the similar but much rarer affection in adults, and specified more particularly that the lesion occurred at the junction of the fifth and sixth cervical roots of the brachial plexus. He thought it was due to direct pressure at this point ("Erb's point"). The teachings of Duchenne and Erb have dominated the minds of medical men until within recent years. It is true that Küstner, in 1889, stated that all such cases seen by him really were instances of separation of the upper epiphysis of the humerus; but his views were not accepted by others. Moreover, Whitman, in 1905, in a brief paper which seems to have been completely ignored until recent years, called particular attention to posterior dislocations of the shoulder often associated with this condition, and urged rational treatment of the dislocation when present on the plan adopted in cases of congenital dislocation of the hip. He expressed the belief that true congenital dislocation of the shoulder was exceedingly rare, as was also a dislocation due to injury during birth; holding that the posterior dislocations so often accompanying brachial birth palsy were the result of the paralysis, not of the birth injury. A. S. Taylor, still upholding

* Read before the Philadelphia Academy of Surgery, October 1, 1917.

the purely neurogenous theory, reported in 1907 a series of cases in which operation had been done by him on the brachial plexus, and referred to some experiments by himself (1905) tending to show that it was possible for the roots of the plexus to be ruptured by traumatism (see paper by Clark, Taylor and Prout).

Meanwhile, general surgeons had been studying cases of the similar lesions seen in adults, to which Erb at first called special attention. Duval and Quillain, in 1898, as a result of their studies, came to the conclusion that there were no such clinical entities as paralyses due to lesions of the brachial plexus, only two types existing, *radicular* and *terminal*, affecting either the spinal motor roots or the nerve-trunks below the plexus. Subsequent observations appear to have confirmed these conclusions, both as regards the injuries occurring at birth and those encountered during adult life. Delbet and Cauchoux in 1910 collected 36 cases of paralyses complicating dislocations of the shoulder: 25 of these were *terminal* paralyses, and were the sole lesions produced by the dislocation itself; the remaining 11 lesions all were *radicular* and were due not to the dislocation, but to the cause which produced the dislocation. There were no true lesions of the brachial plexus in this series.

Now T. Turner Thomas, who had been studying the "stiff and painful shoulders" for which Codman and others have erected a pathology based on so-called subdeltoid bursitis, turned his attention to the pseudoparalyses often, if not indeed usually, present in these cases, and at a meeting of the Philadelphia Academy of Surgery in October, 1910, proposed the theory, to which he has steadfastly adhered, that in almost all such cases, birth injuries or adult injuries, the supposed paralyses are secondary to a primary lesion of the capsule of the shoulder-joint; that the effused blood, lymph and synovial fluid catch the nerves in cicatricial tissue; and that the dislocation so frequently accompanying the birth injuries is primary, and therefore the cause, not the result, of the brachial palsy. Similar teachings were subsequently (June, 1912) promulgated by Lange; but neither Lange nor Thomas has been able to secure general recognition of the truth of their doctrines.

Sever and J. J. Thomas (1916) have recently published two studies based on 470 cases of brachial birth palsy, personally observed by one or both of them. Sever refers to his "numerous dissections on infantile cadavers" which showed that "traction and forcible separation of the head and shoulder puts the upper cords, the fifth and sixth cervical roots of the brachial plexus, under dangerous tension." This confirms Taylor's experiments of eleven years previously, and it may perhaps be accepted as proved that such a lesion can occur during obstetrical delivery by a similar mechanism.¹ The theory of direct pressure on the plexus as a cause has been abandoned. In his experiments Sever was unable to rupture the joint capsule, to separate

¹ However, it may well be, as suggested in a personal communication by T. T. Thomas, that the preservative fluid makes the brachial plexus of infantile cadavers more prone to laceration than is the plexus in the normal baby at birth.

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the epiphysis, or to dislocate the head of the humerus. He notes, however, that in 1900 Stone had been able easily to separate the epiphysis; and T. T. Thomas says (*loc. cit.*, 1914, p. 212) that he has in several infant cadavers obtained by hyperabduction an epiphysial separation or a fracture of the upper end of the humerus, but the capsule was stronger than the humerus, as suggested by Lange. But the contention of Thomas is that rupture of the capsule is produced not by hyperabduction (which, as already noted, produces epiphysial separation or fracture) but by direct pressure on the humerus and acromion by the maternal pelvis, the arms being flexed and adducted at the shoulder (*loc. cit.*, 1914, p. 212).

As a result of these divergent views of the pathogenesis of the condition, there has been equally great divergence in the methods of treatment recommended; and until within the past ten years no very active treatment of any kind has been instituted even by neurological or orthopaedic surgeons. My own active interest in the condition was aroused not much more than five years ago, by the apparently increased frequency with which patients of this type were being seen, and the consequent necessity of systematizing their treatment. My views of the pathogenesis were briefly expressed in discussing the views of Thomas already noted (*Trans. Phila. Acad. Surg.*, 1914, xvi, 235; *ANNALS OF SURGERY*, 1914, lix, 142). These views I still hold:

"First, that pure nerve lesions occur, and may be of much greater importance than any injury to the shoulder-joint even if this is present; and, second, that posterior subluxation of the humerus is a frequent lesion, often overlooked, and perhaps may be the cause of persistence of paralysis." Dr. Thomas, in reply, said "that he did not mean to say that none of these cases of birth palsy were due to rupture of the brachial plexus, but he believed that none of his twelve cases were. He thought it fair to say that most cases are not."

Formerly, babies with "birth palsy" which came under my notice at the Orthopaedic Hospital, in the services of my chiefs, G. G. Davis and R. H. Harte, usually were referred to the Nervous Department of the Hospital, and seldom or never returned for observation by the surgeons. I remember asking the neurologists what became of such patients in adult life; and the consensus of opinion seemed to be that they all recovered without disability, as none of the neurologists whom I questioned had ever seen an adult who had had "birth palsy." I remember also that occasionally when these babies were brought to us at a very early age and the shoulder seemed particularly painful, the diagnosis made was epiphysial separation of the upper end of the humerus; then they were retained under surgical care, the arm bandaged to the side or in a sling, until acute symptoms subsided, and, after being referred to the mechanotherapeutic department for massage, were again lost to sight. I remember only one case diagnosed as "congenital dislocation of the shoulder"; this was in a boy of seven years or thereabout, with a subspinous dislocation of the left shoulder, and with the history that it had been present from birth. There was no question of the presence of the dis-

location; and though the question of the etiology (whether truly a congenital deformity, or from trauma during parturition) was discussed, no satisfactory conclusion was reached, and as no active treatment was urged, the patient did not return. There was only slight disability and no apparent paralysis.

When I began to pay particular attention to these patients, stimulated largely by conversations with G. G. Davis and T. T. Thomas, it did not take very long to learn that the reason they had ceased to be brought to the clinic was not because no disability remained (though this was the case in a few) but because the parents were led to believe the condition was hopeless and that nothing more could be done.

It is the contention of the neurologists that the lesion occurs in most cases at the junction of the fifth and sixth cervical roots as they join to form the upper cord of the brachial plexus. This point is just above the origin of the suprascapular nerve supplying the external rotators of the shoulder; and it is these muscles which are most constantly paralyzed. They point out, moreover, that from the fifth and sixth roots comes also the musculocutaneous nerve, supplying the flexors of the elbow (biceps and brachialis anticus); while the axillary (circumflex) nerve supplying the deltoid (usually also paralyzed) comes almost entirely from the fifth cervical. But they conveniently ignore, or seek to explain by plausible arguments, contrary facts, such as that the very same nerve roots transmit fibres for the subscapularis muscle, the pectoralis major, the latissimus dorsi, the teres major, and the pronator radii teres muscles, none of which, as a rule, exhibit any lasting paralysis, if indeed they were not intact from the very moment of the injury. A. S. Taylor, Fairbank, Sever, and others, all acknowledge the truth of the common teaching that the subscapularis is supplied by fibres derived solely from the fifth and sixth cervical, and yet it is never found paralyzed. Fairbank alone boldly faces the dilemma, and, though he admits freely that this muscle by its contraction is responsible for the posterior subluxation of the shoulder, being unopposed by the paralyzed external rotators, puts forth this explanation: that "recovery of the nerves has taken place before this deformity has occurred or at any rate become fixed, and in cases in which the paralysis is permanent the subluxation does not occur." This is clearly an untenable theory: if recovery of the nerves to the subscapularis occurs with such regularity, why does not recovery of the nerves to the other muscles also occur, if the lesion has been where all the fibres pass in a common trunk? Moreover it is simply not true that posterior luxation does not occur when the paralysis is permanent; witness my Case V. Unless, indeed, he means that posterior luxation does not occur if the subscapularis remains paralyzed; but I do not know of any cases reported in which paralysis of this muscle has been observed. A. S. Taylor seems to have had but a confused idea of the effect of these paralyses: he refers to the deformity which develops from *contractures of the paralyzed muscles and the ligaments of the joints*. Thus he assumes that *contracture* of the subscapularis occurs because it was paralyzed (of which there is no

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evidence), but he attributes *relaxation* of the external rotator muscles to their paralysis, and yet considers the limitation of elbow extension due to *contractures* of the paralyzed flexor muscles. It is despair over a theory such as this, which blows hot and cold out of the same mouth, that encourages others than neurological surgeons to look elsewhere for an explanation of the phenomena encountered in this still obscure condition.

Unless the anatomy commonly known is incorrect, I do not see how the immunity of certain muscles, especially of the subscapularis and teres major, can be explained, if the nerve lesion is supposed to be at the juncture of the fifth and sixth roots. The descriptions of what has been found at operation soon after birth are so vague that not much reliance can be placed on such observations; this vagueness probably is due to the impossibility of telling, even with the nerves exposed to view, how much they were damaged. In cases operated on months or years after the injury occurred, the extent of the scar tissue and the difficulty of the dissections render such observations also of limited value. It may well be, as indicated by some of these operations, that the suprascapular nerve itself (below the plexus) is damaged at the time of the original injury. Indeed it has occurred to me that it may be not improbable that all the nerve lesions in the majority of these cases are *terminal* and not *radicular*. Consider the course of the nerve-trunks (*terminal*) which supply the various groups of muscles: *all the muscles most constantly paralyzed are supplied by nerves which pass very close to the shoulder-joint*² and *ipso facto* are liable to injury; whereas *the muscles which habitually escape paralysis are supplied by nerves which at no part of their course come into close relation with the shoulder-joint or the bones which compose it.*³

This seems to bring us very close to the theory of Thomas and Lange, that the primary lesion is in the shoulder-joint, and that involvement of the nerves occurs secondarily. It is indeed a question in my own mind whether this is not the most acceptable theory for the majority of cases; but as already stated, I do believe that radicular lesions of the nerves occur, though in a comparatively small proportion of the total number of cases of birth injury.

When lesions in nerves occur by overstretching, it is accepted that rupture of the sheaths occurs first, permitting hemorrhage among the nerve fibres; eventually, if traction is continued, partial or complete rupture of the nerves themselves occurs. Any degree of injury, trifling or complete, may occur in this way; and it is a matter of common experience that in almost all cases of birth injury a remarkable improvement occurs without any operation, if proper non-operative treatment (massage and passive movements to prevent contractures) is begun soon after birth (Case I). Hence it is safe to assume,

² These include the suprascapular (most often injured), musculocutaneous, and the circumflex; the musculospiral also is frequently injured.

³ These include the subscapular nerves, the median and ulnar nerves, the anterior thoracic nerves (to the pectorals), and the nerves to the rhomboids and to the serratus magnus.

in the majority of cases, that the nerve lesion, wherever and whatever it is, is not very extensive, and that in such cases no operation on the nerves is advisable. But there are cases, few in number, in which to my mind the evidence of extensive nerve lesion is undoubted (Cases IV, V, VIII, X, and XIII); Sharpe speaks as if he had had experience with this class of patients alone, and at least it is to be hoped that he is not subjecting all the milder cases to exploratory operation on the nerves. He says he has operated on 56 patients in all. Unfortunately none of his cases are reported in detail, and it is impossible to judge how much improvement has been secured, and especially whether any greater improvement has been secured than may be obtained by non-operative means. Most of his operations probably were too recent for end-results to be available; but until he can show better end-results than are being secured by others without operation on the plexus, he cannot expect his views to have great influence. His chief argument in favor of early operation appears to be that even if it proves useless it will be harmless. He acknowledges that it is usually impossible to tell without direct inspection of the nerves whether or not they are seriously damaged; but he contends that it is more to the patient's interest to have an exploratory inspection of the nerves than to wait until it may be determined clinically whether or not serious nerve damage is present. In cases of apparent "total paralysis" he urges operation at the age of one month; half of those patients so treated, he says, have shown marked improvement. But it is equally true that at least half, if not more, of such patients treated without early operation also show marked improvement; it is true they do not recover nearly as good function as do those patients in whom soon after birth the apparent paralysis was not total. Those infants he has operated on at the age of three months have shown more constant improvement, because, he claims, the paralysis was less severe at first; but he believes a still greater improvement would have occurred if operation had been done at the age of one month; and he seems to urge this early resort to operation in *all* cases in the future. Older patients, he says, give the worst results. In opposition to operative measures to lessen the mechanical disability of the patient (by reducing the dislocation, if present, by tenotomies of shortened muscles, etc.) he states: "I have yet to see cured by this method of treatment one case of brachial plexus paralysis in which at birth there was total paralysis of the arm, hand and fingers." Improvement, he admits, may occur even without any treatment, but he thinks it rarely continues beyond one year of age, and a useful arm is never obtained. If he really limits his remarks to cases of "total paralysis," probably all will agree with him, but will point out that no such cases have been "cured" by neurological surgery.

As regards *treatment*, then, I reject nerve operations in early infancy. Babies are seldom if ever seen for the shoulder injury until they have reached the age of three or four weeks. At this time they either have or have not a demonstrable dislocation.

In case *no dislocation is present*, I believe the proper treatment consists,

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as pointed out by G. G. Davis, in keeping the hand and arm in front of the body (so as to prevent extension of the elbow and excessive internal rotation of the shoulder) by putting the arm in a sling or by pinning the sleeve to the front of the dress. In addition, as soon as the soreness of the birth injury permits, passive motions should be instituted, especially external rotation and abduction of the shoulder, to prevent shortening of the subscapularis and anterior capsule. Massage also is of value, and above all the child should be encouraged to make active movements of the kind indicated above. Electricity certainly has some value, at least in children of the age of six months or older. I think its value in early infancy is open to question. If these patients are treated in this way from the time of birth, most will recover with little permanent disability. In a few such patients, and in most of those seen for the first time a number of months after birth (especially if dislocation of the shoulder is present), additional measures will be necessary as detailed below.

In case dislocation is present: In some patients there can be no doubt that the dislocation was present at birth; but it is a question whether there are any examples of dislocations of the shoulder which were present *in utero*, i.e., truly "congenital" dislocations.⁴

It is possible in some babies seen very soon after birth that proper treatment as above indicated will secure reduction of the dislocation by passive motions (Case IV). But in all cases where the dislocation is at all pronounced, I think it is advisable to anæsthetize the child at about the age of six months, and to reduce the dislocation bloodlessly in a manner analogous to that employed by G. G. Davis in treating congenital dislocations of the hip: the baby is placed prone on a well-padded orthopædic table, with the affected extremity hanging over the side of the table. Owing to the internal rotation of the humerus the arm will not hang vertically downward, but will point toward the patient's feet. First, this internal rotation should be overcome by very gently but persistently rotating the humerus outward by means of the flexed forearm. When the forearm has been brought thus into the horizontal plane (the coronal plane of the patient's body) direct downward pressure should be made on the head of the humerus, which usually will be felt to jump forward into normal relation with the glenoid process. Reproducing the dislo-

⁴I do not know how to explain the conditions encountered in Case IV. It is difficult to explain the persistency with which the arm rebounded to the highly abnormal position in which it was found at birth unless we admit that this position had been long maintained *in utero*. Though the labor in this case was difficult ("version was attempted"), it might be that the difficult labor was caused by the malposition of the arm *in utero*, not that the labor produced this malposition. Certainly in all ordinary recent traumatic dislocations, when the dislocation is reduced the deformity does not recur immediately, as it did in this patient during a period of from three to four months after birth. However, in this patient there is no reasonable doubt that there was injury in birth, since even as late as May, 1917, when the child was in her fifth year, considerable paralysis remained, the hand being almost useless, though the shoulder and elbow were normal.

cation and again reducing the head several times will leave no doubt in the mind of the operator or assistants that proper reduction has been secured. When the head of the humerus has thus been forced out onto the glenoid eminence, it will be found that the elbow can no longer be fully extended, owing to the shortening of the flexor muscles (long and short heads of the biceps and the coracobrachialis). This is analogous to the shortening of the hamstrings produced by reduction of a congenital dislocation of the hip. As in the case of the hip, so also at the shoulder, the head of the dislocated bone may be palpated anteriorly so soon as reduction is secured. It still remains to secure abduction of the shoulder-joint. This is most safely done by moving the child away from the edge of the table, so that the arm no longer hangs over the side of the table but lies upon it. With the flexed elbow lying upon the surface of the table, and the child's chest flat on the table, it will be observed that the shoulder is kept some distance above the table, by the tension of the anterior capsule and subscapularis muscle. Intermittent downward pressure is then made upon the posterior surface of the shoulder until its anterior surface comes into contact with the surface of the table. Then the elbow (still flexed) is very gradually raised from the table, by placing beneath it first one, then two, and later three or four folded towels, while intermittent downward pressure is made on the posterior surface of the shoulder. This process should be continued until the elbow lies well posterior to the frontal plane of the patient's body. There will now be little tendency for the dislocation to recur, and the entire upper extremity and chest are to be encased in plaster-of-Paris to maintain this position. This gypsum case should be retained for six weeks, when it should be renewed, with the arm in the same position; the second case should not be removed for six weeks more, thus maintaining reduction in the overcorrected position for a period of three months. If a shorter period of overcorrection is permitted, the dislocation tends to recur, especially in older patients. I have found that after the age of four years bloodless reduction is not efficient. It does more damage to the structures of the joint, and accomplishes less than bloody reduction by arthrotomy.

In patients over four years of age I recommend the following method for reduction of the dislocation:

A curved incision is made, as advised by Senn, around the acromion and about 3 to 4 cm. distant from it, from the coracoid process in front to the spine of the scapula behind (Fig. 1). This incision is deepened until the deltoid is exposed, and the skin and fascia are then turned upward as a flap, thoroughly exposing the acromion and the acromioclavicular joint. An incision is then made through the fascia and periosteum covering the spine of the scapula, and this spine is bared by stripping the periosteum from it until a guide can be passed under the base of the acromion, to protect the suprascapular nerve and vessels (Fig. 2). The acromion is then osteotomized obliquely at its base, the acromioclavicular joint is opened, and the acromion is turned forward, carrying with it the deltoid (modification of Kocher's

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method for excision of the shoulder). This thoroughly exposes the upper aspect of the shoulder-joint (Fig. 3). The long tendon of the biceps is identified; on its median or anterior border lies the lesser tuberosity, while laterally or posteriorly lies the greater tuberosity.⁵ To secure normal external rotation of the shoulder, the insertion of the subscapularis is now divided while kept under tension by an assistant endeavoring to rotate the humerus outward. At once reduction of the posterior dislocation becomes possible without difficulty, and usually abduction also now becomes free; but if it is still resisted it may be necessary to divide or lengthen the tendon of the pectoralis major through a separate incision. Next, while the humerus is maintained in full external rotation and abduction, the tendons of the supraspinatus and infraspinatus and teres minor muscles, as they insert into the greater tuberosity, are plicated by mattress sutures of chromic gut, thus shortening them, and maintaining the head of the humerus in its forward and externally rotated position. The acromion is now replaced. In some cases it is so much deformed that it will no longer fit in its former position, as the place its tip formerly occupied is now held by the reduced head of the humerus. It is then necessary to remove a section from the sawn surface of the acromion, in order to raise its tip out of the way of the shoulder-joint (Case X). The acromion in younger patients is largely cartilaginous and may be held in place by sutures of chromic gut including the overlying periosteum, fascia and muscles, as well as the bone; but in older patients screw fixation is preferable. The skin flap is then replaced, and sutured without drainage, the arm being constantly maintained in the "light-house position." The plaster-of-Paris dressing is not to be changed for six weeks, when a new similar fixed dressing is applied for a second period of six weeks.

After removal of the dressings it is important to resume active and passive movements, especially to encourage external rotation, abduction and supination. I have adopted this operation in five cases, with no recurrence in any patient, and marked improvement in all (Cases V, VI, VII, VIII and X).

Even in older patients where no dislocation is present, very great disability may be caused merely by muscular contractures, and this may be relieved much more rapidly and efficiently by operative means than by prolonged courses of passive movements and gymnastics. The greatest disability in all these cases usually is due to *loss of supination* and to *loss of external rotation at the shoulder*. Even when all the muscles are strong and active, the children cannot get their hands to their mouth without abducting the humerus (owing to the fixed internal rotation), and in many cases they cannot get their hands to their mouths at all, even in the position of pronation.

⁵ In several cases I have found the bicipital groove located directly in the line of the external condyle, owing to excessive internal rotation of the shaft of the humerus below the tuberosities, presumably due to the unopposed action of the unparalyzed pectoralis major and teres major muscles. Hoffa, it should be recalled, treated some of his patients by osteotomy of the shaft of the humerus about its centre, rotating the lower fragment outward. This, however, does not overcome the chief cause of disability, namely, the internal rotation at the shoulder-joint, where the subscapularis is tense.

Treatment by a series of plaster cases, endeavoring to overcome the contractures gradually, as in some contractures of tuberculous joints, has also been tried in my clinics, but has not been found so efficient as the cutting operation. For this purpose an anterior incision is made, as for excision of the shoulder, passing through the anterior fibres of the deltoid; the long tendon of the biceps is identified, and then the lesser tuberosity, where section is made of the tendon of the subscapularis. If contracture of the pectoralis major prevents full abduction, its tendon may be lengthened by Z-plasty or may be completely divided, through a prolongation downward of the same incision. I have not observed any disability to follow complete section of the tendon of this muscle, and believe it is simpler and therefore preferable to a formal lengthening operation.* I have employed this operation for birth injury of the shoulder in two cases (Cases XI and XII), and my assistant, Dr. A. Bruce Gill, has also adopted it with satisfaction.

In one case in the present series the disability at the shoulder arose chiefly from the paralysis of the deltoid; this was entirely relieved by transplantation of the pectoralis major to supplant the deltoid (Case XIII). In this same patient there was great disability as well from the residual paralyses in the forearm; function was materially improved by tendon transplantations.

In a fair proportion of patients with birth injury at the shoulder, who have not received adequate treatment soon after birth, considerable disability persists from deformity at the elbow. It is possible that the elbow is injured at the time of birth, but I am inclined to believe that the main deformity is gradually developed as the result of the malposition in which the elbow is held. The forearm is kept in full pronation, the elbow slightly flexed, and the whole limb internally rotated. The head of the radius gradually grows upward past the external condyle, and when seen in adolescence the patient may present a complete posterior dislocation of the head of the radius, as in Case X of the present series. All grades of subluxation may be present. It is known that in cases of hereditary deforming chondrodysplasia posterior dislocation of the radius is not unusual, owing to the lack of equal growth of the ulna; and it may be that disuse of the forearm and use of the hand (which is the usual state of function in patients with birth injury of the shoulder) tend to produce lack of development of the ulna (which is an elbow and forearm bone) and full development or even overdevelopment of the radius (which belongs rather to the wrist and hand than to the elbow or forearm).

The case histories which follow have been selected to illustrate the prognosis and treatment of certain types of the affection:

(1) The usual mild case, recovering nearly perfect function under treatment by massage, passive and active movements, etc. (Case I).

* Fairbank in 1913 described an operation similar to this, and Sever has lately described a modification of it as an original procedure; his modifications consist in making the incision in the deltopectoral groove (where the cephalic vein is in the way), and in dividing the tendon of the subscapularis on a grooved director.

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(2) The same type of case, but complicated by posterior dislocation of the humerus (Cases II and III).

(3) The severe type, in which the residual paralysis causes far more disability than could any dislocation (Cases IV and V).

(4) The typical case of subspinous dislocation coming under treatment late, and with no disability except that due to the joint deformity (Case VI).

(5) The typical case of subspinous dislocation with moderate paralytic disability (Cases VII, VIII, IX, and X).

(6) The typical case of disability from contractures without either dislocation or paralysis (Cases XI and XII).

(7) The unusual type of flail shoulder (Case XIII).

The frequency of subspinous dislocation in the patients under my care is worth noting; it was present in more than 40 per cent.

Another feature which I think bears emphasis is the frequency with which two or more children in the same family are affected: in one instance three sisters were similarly injured in birth, and the fourth child was killed during delivery. In several other instances brothers or sisters have died at or soon after birth from injury; in one case (Case VI) 5 other children were killed at birth. There is room here for improvement in obstetrics.

CASE I.—Birth injury of the right shoulder without dislocation; recovery under treatment by massage and active and passive movements. Mollie R. was brought to the Orthopædic Hospital October 10, 1914, at the age of ten weeks. It had been a footling presentation, easy labor of four hours' duration, no instruments being used. There was one older child, now three years old.

Examination.—The right shoulder is held quietly by the side, in internal rotation. She makes no attempt to move the shoulder, but she moves the fingers slightly. No dislocation is present. The electrical report by Dr. Cadwalader shows that the deltoid does not react to Faradism, and Galvanic current causes too much pain to be used.

Treatment.—Massage and passive motions, three times weekly.

November 26: Has fair grasp in hand, uses arm a little. It can be passively raised above head and placed behind back. External rotation is limited a little within the sagittal plane.

January 9, 1915: External rotation is possible beyond the sagittal plane.

February 13: Nearly seven months old. Dr. Cadwalader reports: probably complete reaction of degeneration in the deltoid; no reactions of degeneration in other muscles.

June, 1915: Uses hand and arm all the time.

August, 1915: No dislocation has developed. Fair power has returned in the deltoid.

December, 1915: Puts hand to mouth in semisupination, and with shoulder slightly abducted. Scarcely any limitation of passive external rotation or abduction.

July, 1916: Can raise right arm above head almost as well as left arm. Puts hand to mouth and top of head easily, and can be placed behind back passively with ease.

October, 1916: Right arm almost normal. Dismissed from further treatment at the age of twenty-six months.

CASE II.—*Subspinous dislocation of right humerus; bloodless reduction at age of six months.* William A. F. was first seen at the Orthopædic Hospital November 6, 1913, at the age of three months. He had one sister, six years old, who was normal. This boy had been injured in birth which was not instrumental (L. O. A.) There had been a cephalhæmatoma at birth, over the right parietal, and this region was still palpably thickened up to the age of four months. He held his right arm at the side, in internal rotation, and all shoulder motions were limited, especially abduction. He has pain when the arm is moved. The hand, fingers and wrist are kept flexed, and the hand is in ulnar adduction. There is good power in the triceps, and a good grip in the hand, but no power of flexion of the elbow. The head of the humerus was palpable beneath the spine of the scapula, and a skiagraph (Fig. 4) showed the epiphysial centre for the head of the humerus not opposite the glenoid as on the normal side, but luxated out and up. As the child was brought from out of the city, the mother was directed to make the necessary manipulations at home.

December 4: The shoulder still is tender. When the humerus is abducted and externally rotated to the limit and pressure is made forward on the head of the humerus a distinct grating click or snap can be felt as the head slips over the posterior border of the glenoid. Active flexion of the elbow has developed.

February 5, 1914: Head of humerus still dislocated posteriorly, so on February 7, under ether anæsthesia, bloodless reduction was done, and the arm dressed in the light-house position. The child was taken home the same day, and the mother later reported that almost at once he began to show better use of his hand. Three weeks later it was noted that fair power of extension of the fingers had developed.

March 28: New gypsum case was applied, the humerus remaining in proper position.

May 7: Gypsum dressing permanently removed, the shoulder remaining reduced.

May 28: Since last note mother says he has been using the hand "just like normal." External rotation still limited at sagittal plane.

August 8: Can get hand to mouth, but only in pronation.

January 23, 1915: Uses right hand more than left, and beginning to hold his hand in supination. Active and passive exercises have been continued all the time.

March 20: Good extension in fingers, but none yet in wrist.

January, 1916: As progress seemed slow during the past year, the arm was again dressed in full abduction and external rotation in plaster-of-Paris (applied without any anæsthetic, at the limits of movement), and this dressing was worn for seven weeks. The power of supination and external rotation was decidedly improved when the cast was finally removed.

July, 1916: It was noted that the power of extension of the fingers and wrist was good.

December 30, 1916: Still prefers to use the left hand. Active movements: supination not quite complete, external rotation of

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shoulder only to sagittal plane; abduction and elevation of upper extremity about 30 degrees short of vertical. Passive movements: supination complete, external rotation about 20 degrees beyond sagittal plane; abduction (without elevation of scapula) about 50 degrees (limited by axillary fold muscles). There was a slight hollow beneath the acromion in front, and the head of the humerus was just palpable posteriorly beneath the spine of the scapula (subluxation).

March 10, 1917: The accompanying photograph (Fig. 5) was made, showing the boy putting his hand to his mouth.

CASE III.—*Birth injury of right shoulder, first seen at age of seven weeks. Dislocation of shoulder not observed until age of three years.* Ida May F. came to the Orthopædic Hospital when seven weeks of age, June 8, 1911. This was the first baby in the family, a head presentation, instrumental delivery.

Examination showed the right arm hanging by the side in internal rotation. The hand grasp was good; the anteroposterior motions (flexion and extension) of the shoulder were good, and abduction was fair. She could not flex the elbow. Passive motion was normal throughout, and there was no pain on motion. The epiphysis rotated with the shaft. There was some crackling in the region of the shoulder-joint.

Treatment consisted in bandaging the arm in the Velpeau position for two weeks; then massage, passive movements and electricity were given.

October 5, 1911: Can flex elbow, and has more use of shoulder, but it is still in internal rotation.

March 28, 1912: Slight improvement in strength.

June 11, 1914: Careful reexamination reveals a posterior subluxation of the humerus at shoulder, with a hollow beneath the acromion. The use of hand and elbow are good. There is still limited abduction and external rotation at the shoulder. (It is highly probable that a more attentive examination soon after birth would have detected the posterior luxation of the shoulder; attention was now directed more particularly to this deformity on account of T. T. Thomas's paper.)

March 13, 1917: The child is now six years old. She was treated by massage and passive motions until two years ago. She now gets her hand to her mouth only with the forearm in midpronation and with the arm abducted. She gets her hand to her back easily and fastens her own petticoat. Supination is weak. There is no external rotation at the shoulder beyond the sagittal plane. A slight posterior subluxation of the shoulder persists. She uses her right hand normally, but prefers to use the left. Function could be improved by tenotomy of the subscapularis, and perhaps of the pectoralis major.

CASE IV.—*Subspinous dislocation (luxatio erecta) of left humerus from birth injury; persistent paralysis of hand.* Agnes T., ten weeks old, seen at Orthopædic Hospital, March 7, 1913. This is the fourth child, the previous births being normal. In the present instance "version was attempted" and at birth the left forearm was folded across the front of the baby's neck, in full pronation, and it has constantly rebounded to this position ever since when not held down by a bandage. The mother says that when two weeks old a long splint from axilla to

palm was applied by the family physician, and was kept in place for two weeks; and that when it was removed the child could not move her fingers as well as when first born.

Examination at the age of ten weeks: the arm is held abducted to 90 degrees, and the head of the humerus is palpable beneath the spine of the scapula; there is some grating on attempts at rotation. A bony lump in the axilla is thought to be the glenoid. There is no active power to extend the fingers, wrist or elbow.

Two or three weeks later, the arm having been bandaged to the side constantly, it was noted that the arm stays almost against the side without being held down, and it is assuming the typical posture of "obstetrical palsy."

August, 1913: Now eight months old: the arm comes easily down to the side, and the head of the humerus stays in the glenoid. Wrist drop and paralysis of the triceps persist. Fair power in biceps, and fair grip in fingers; no power in axillary fold muscles; deltoid is doubtful.

October, 1913: Head of humerus is clearly anterior to acromion and there is no palpable deformity as compared with the uninjured side. Grip is good, the hand as a rule staying clenched and the wrist flexed, but not so persistently as before. No power yet in musculospiral; some power in pectoralis major. Dr. H. P. Boyer reported that the electrical examination of the muscles was a little doubtful, but he thought there was no reaction of degeneration in the pectorals or the extensors of the fingers. There was "some response to the Faradic current."

June, 1914: Very little further improvement has occurred. Massage and electricity have been given twice weekly. She can now abduct her shoulder (deltoid) to 90 degrees; the axillary fold muscles are good, and the biceps is good. There is no power in the triceps or in the extensors of the fingers; there is very slight power in the flexors of the fingers. The fingers are still held clenched and the wrist flexed. Passive movements: external rotation at the shoulder is easy to beyond the sagittal plane; the elbow can be extended to 170 degrees, supination is normal, but pronation a little limited. The mother says the child has been *biting* her hand (not very hard) for four or five months. A posterior splint was applied to keep the fingers and wrist in extension, and all other treatment was suspended.

August, 1914: Does not bite hand any more; hand no longer stays flexed, but there is no power in the fingers nor in the extensors of the wrist. The posterior splint was continued.

November, 1914: Has learned to hold a glass of milk or water in the bent elbow and drinks easily from it.

January, 1915: Burned the left elbow a few days ago, and it seemed to give her no pain. The finger nails of the paralyzed hand require to be cut about three times as often as those of the normal hand, the latter being worn down by use.

March, 1917: Now four years of age. The hand is useless—in flexion and ulnar deviation; she can barely flex the fingers. The biceps

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and triceps have very fair power. She gets the back of her wrist to her mouth, and holds articles in the bend of her elbow with great security.

CASE V.—*Subspinous dislocation of humerus, with complete flaccid paralysis of arm; reduction by arthrotomy.* Catharine B. came to the Episcopal Hospital in September, 1913, when past three years of age (Fig. 6). There were two older children: the first (now seven years old) had the left shoulder "broken in birth"; the second child (now six years old) had "the nerve hurt" in birth (right shoulder), but "both came all right about six weeks after birth." (See Cases Va and Vb). A fourth child, born subsequent to this visit (in May, 1914) was killed during delivery.

Catharine was born head first, and no instruments were used. She seemed to have no sensation in the left arm. It has always been utterly useless. She chews the fingers, and has burned the hand several times without evincing any sensations of pain.

Examination.—There is complete flaccid paralysis of the left upper extremity; probably, it was thought, the lesion was a tearing out of the roots of the brachial plexus from the spinal cord. She has been seen by nerve specialists and orthopaedic surgeons, who told the mother nothing could be done. Owing to the complete absence of sensation, persisting for over three years, this seemed reasonable advice, and it was repeated.

June 15, 1914: Nine months after the first examination the child was sent for, for reëxamination, especially as it had not been noted at the first examination whether or not there was a posterior dislocation of the shoulder. To-day it is learned that the child has not burned her fingers since Christmas, and that soon after the first of the year she began to move her fingers. She can now flex the shoulder slightly. The axillary muscles have fair power; there is some power in the biceps, and she can extend the wrist well. There is a subspinous dislocation of the humerus. Operation was now recommended to secure reduction of the dislocation, since it had been determined by an experience with six cases of reduction of similar dislocations (three "bloody" and three "bloodless" reductions), all treated since this patient was first seen, that a considerable degree of improvement might be expected in apparently paralyzed muscles if deformities were overcome and the weak muscles were allowed to work at a better advantage.

Operation (December 28, 1914).—Patient now four years of age. Senn's incision, with temporary resection of the acromion. The acromion was cut at its origin from the spine by an osteotome, but in turning it forward the acromion fractured through its epiphysial cartilage. The intervening detached piece of acromion was laid aside in dry sterile gauze and was re-implanted at the conclusion of the operation. The tendon of the subscapularis was divided, thus allowing external rotation of the humerus until the flexed forearm was in the coronal plane. The head of the humerus was thus easily and fully reduced to its normal position. The tendons of the supra- and infraspinatus muscles were then shortened; the detached piece of the acromion was replaced and fastened to the spine of the scapula by a small Lambotte screw; the cartilaginous tip of the acromion was turned up again and sutured to

the periosteum covering the head of the screw; and the fascia and skin were closed with interrupted chromic gut sutures. The arm was dressed in abduction and external rotation, in plaster-of-Paris.

January 9, 1915: Went home.

February 15, 1915: New case applied. One granulation in the line of incision.

March 29: Case removed. Massage ordered. Incision healed.

April 10: Can get hand to mouth, but only with arm in abduction. Has fair power of flexion and extension in elbow, but scarcely any motion in hand.

November 15, 1915: Dislocation stays reduced; the acromion is solid. She can put her hand to her mouth with forearm in pronation and the humerus abducted. She has no active external rotation; has slight power in the triceps, can flex elbow to 45 degrees, and there is passive extension of the elbow to 150 degrees. She has some power in the extensors of the wrist, very slight power in the thumb, fair pronation and supination. There is no power in the other muscles of the hand.

CASE Va.—Subspinous dislocation of left shoulder; slight disability. Anna B., aged seven years, is the eldest sister of Catharine B. (Case V). It was a head presentation at birth, and no instruments were used; but after the head was delivered, the shoulders stuck, and the labor was difficult.

Examination.—The mother brought this child to the Episcopal Hospital, June 15, 1914, by request. Except for the fact that the baby's "shoulder had been broken in birth" it was thought that she had recovered perfectly by the age of six weeks. Examination showed, however, that there was a subspinous dislocation of the humerus, with the characteristic internal rotation of the arm, which was carried into marked abduction on putting the hand to the mouth. Treatment was declined by the parent, and was not urged, as the disability was slight (Fig. 6).

CASE Vb.—Birth injury of right shoulder, without dislocation of the humerus. Mary B., aged six years, was the sister of the patients already described (Cases V and Va). She was brought to the Episcopal Hospital for examination, by request, June 15, 1914. There was the characteristic attitude of carrying the injured limb, with the arm in internal rotation and the forearm pronated. No dislocation of the shoulder was present, but there was limitation of external rotation and of supination, and in carrying the hand to the mouth the arm was forced into marked abduction. The disability was so trifling that no treatment was recommended (Fig. 6).

CASE VI.—Subspinous dislocation of humerus, reduction by arthrotomy. Theresa M. came to the Episcopal Hospital when five years old, April 5, 1915. She was the youngest of seven children, all but one of the six others having died at birth. In the instrumental delivery of Theresa, the right arm was injured.

Examination.—The arm is held in internal rotation with the elbow flexed; the head of the humerus is absent from its normal site in front of the acromion, and is palpable posteriorly beneath the spine of the scapula. She cannot put her hand to her mouth in supination, and in the act the arm is abducted until the elbow is higher than her ear (Fig. 7).

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Operation (April 14, 1915).—Senn incision. Acromion detached and turned down. After section of subscapularis tendon the head of the humerus was replaced in the glenoid; the tendons of the supraspinatus and infraspinatus were plaited to shorten them and maintain the external rotation; and the acromion was replaced and held in position by sutures of chromic gut. The arm was dressed in plaster-of-Paris in full abduction and external rotation.

April 22, 1915: Went home.

May 28, 1915: New plaster case applied.

July 12, 1915: Plaster case removed permanently. Reduction is maintained, but shoulder is stiff and painful.

August 2, 1915: Can get hand to mouth in supination, but motion in shoulder is only about half normal. Continue massage and passive motion.

December 6, 1915: Nearly perfect result (Fig. 7). Can put hand to mouth in supination, and behind head; cannot put it behind back. Extension of elbow to 150 degrees. Has good supination in forearm, has almost normal external rotation, and can abduct arm to 90 degrees.

CASE VII.—*Subspinous dislocation of shoulder; bloodless reduction.* Edward J., four years old, is a brother of Case IX. Three sisters are normal, but the third boy, born February 7, 1916, by instrumental delivery, was killed during birth (his weight is said to have been 16 pounds). When the present patient was examined, in September, 1914, there was a subspinous dislocation of the left humerus, slight cubitus varus, and limited rotation in the forearm. The arm was not so useless as that of the patient's brother (Case IX), but like Tom, he could not get his arm into external rotation, nor his forearm into supination (Fig. 8).

Operation (September 8, 1914).—Bloodless reduction, under ether anæsthesia; with the child lying on his abdomen, and the arm in abduction and the forearm hanging over the edge of the table, pressure was made downward on the head of the humerus, at first with the arm in internal rotation; then gradually, *after* reduction had been secured (ascertained by palpating the head of the humerus in front of the acromion, and observing that the flexors of the forearm had become tense, as do the hamstrings when a congenital luxation of the hip is reduced), the humerus was worked into external rotation. When complete reduction was effected, an upward dislocation of the acromial and of the clavicle was produced. The limb was dressed in plaster-of-Paris, with the humerus horizontal in the coronal plane, and the forearm vertical (full abduction and external rotation of the shoulder). The reduction was attended by a distinct jump and click, was easily reproduced, and again reduced, with characteristic jump and click.

November 6, 1914: Case removed eight weeks after reduction, which was still present.

November 9: Dislocation has recurred.

November 11: Bloodless reduction under ether anæsthesia, as before; dressed in plaster-of-Paris in same position.

December 28: New case applied. Shoulder stays reduced.

February 12, 1915: Case removed, three months after second reduction. Humerus remains in place.

April 10: Good use of hand, but humerus does not stay very far forward. Can get hand to mouth without much abduction of arm, but not in supination (Fig. 9).

March 13, 1917: Two years and four months after reduction. Has had no treatment for two years. He is nearly seven years old. He can get his hand to his mouth only in pronation, barely to his head, and not at all to the small of his back. Passive external rotation of the shoulder is possible until the flexed forearm lies almost in the coronal plane; active external rotation is limited at 45 degrees (mid-way between sagittal and coronal plane). Passive supination of the forearm is limited just beyond the mid-position; active supination stops just short of the mid-position. His arm and hand are very useful and still improving.

CASE VIII.—*Subspinous dislocation of humerus; reduction by arthrotomy.* Joseph B., five years old, came to the Episcopal Hospital February 2, 1914. He was the fourth child of his parents, three older and one younger children being normal. The fifth child was delivered instrumentally, and died in two hours. Patient was also a case of instrumental delivery, and his left arm has been paralyzed ever since birth.

Examination.—He holds the left upper extremity in internal rotation and slightly abducted at the shoulder, flexed at the elbow, and hyperextended at the wrist (Fig. 10). When trying to put hand to mouth he raises arm in abduction and internal rotation, and the flexor surface of the forearm is carried against the mouth (Fig. 10, C). He cannot get his hand to his mouth, and the hand is useless. The head of the humerus is absent from its normal location in front of the acromion and is visible and palpable behind the spine of the scapula. His grip is good, but he cannot flex his wrist. The biceps is good, and there is slight power in the triceps. There is very slight power in the extensor carpi radialis. He cannot flex the index finger as well as the others, nor the thumb; and he cannot extend his fingers. Elbow cannot be extended beyond 160 degrees, and there is cubitus varus (195 degrees, i.e., the forearm falls 15 degrees to the inner side of the axis of the humerus). The axillary fold muscles and the trapezius are good.

Operation (February 7, 1914).—Senn's incision; temporary resection of acromion. Lesser tuberosity could be only very imperfectly exposed until after division of subscapularis tendon, which allowed external rotation of humerus, thus bringing lesser tuberosity into view. The head of the humerus could now be pushed forward in front of posterior lip of glenoid, and dislocation satisfactorily reduced. The supraspinatus and infraspinatus tendons were then shortened by plaiting to maintain external rotation; the acromion was replaced and fixed in position by chromic sutures, and the skin wound closed. Dressed in external rotation and abduction (Fig. 10, D).

February 28: Went home.

May 20: Case removed.

June 1: Massage and passive motions ordered.

August 31, 1914: Shoulder remains in joint. Better motion of the arm. Splint to hold wrist slightly flexed.

January 17, 1916: Has full external rotation, and almost normal

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supination. He can just put his hand to his mouth in supination (Fig. 11). He cannot put it behind his head or behind his back.

March 13, 1917: Now 8 years old, over three years since operation. Puts hand to mouth normally, but wrist remains in hyperextension. There is a strong grip in the fingers. Active flexion of the elbow is normal, but extension is impossible beyond 135 degrees (passive extension to 150 degrees). There is no active rotation in the shoulder, nor any active supination or pronation in the forearm. There is good power in the deltoid. He uses his hand constantly for holding things.

CASE IX.—*Subspinous dislocation of humerus; reduction by arthrotomy.* Tom J., aged six years, with his brother Edward, aged three years (Case VII), similarly deformed, was brought by his mother to the Episcopal Hospital January 22, 1913. After this date the patients were not seen until September, 1914. Boy's left shoulder had been injured in birth, and he has never had any use of the arm. Three sisters are normal, but the third boy, born February 7, 1916, by instrumental delivery, was stillborn (weight said to have been 16 pounds).

Examination (September, 1914).—The left arm hangs in internal rotation, with the forearm in pronation, and is several inches shorter than the right arm (Fig. 8). Finger movements are normal, but there is no active power of extending the wrist, and passive extension is possible only to 165 degrees. The elbow can be extended to 160 degrees, and flexed normally; there is cubitus varus. The head of the humerus is palpable behind the spine of the scapula, and the tip of the acromion is turned down. Active abduction at the shoulder (including rotation of the scapula) is possible to 75 degrees, and passively to 150 degrees.

Operation (September 8, 1914).—Senn's incision, with temporary resection of the acromion. The shoulder-joint was opened above the greater tuberosity, which was the only portion accessible. The head of the humerus lay against the posterior lip of the glenoid process, in posterior subluxation; and where the edge of the glenoid impinged on the humerus a deep longitudinal groove had been worn in the cartilaginous head of the humerus. It now became possible to reduce the luxation by forward pressure, if the humerus was in internal rotation, but impossible if in normal position of rotation, and also impossible to rotate the humerus out after reduction was secured. Therefore the subscapularis tendon was cut from within the joint. At once reduction became easy when the humerus was in external rotation. While the humerus was maintained in reduction, with the arm abducted and externally rotated, the tendon of the supraspinatus was plaited, to aid in maintaining abduction and external rotation; the acromion was replaced and held in position by sutures of chromic gut uniting the deltoid, periosteum and trapezius over it. The skin was similarly closed with chromic gut. The arm was dressed in plaster of Paris in the usual position of abduction and external rotation.

September 14: Went home.

November 6, 1914: Plaster case removed.

December 7, 1914: Humerus stays reduced. Arm no longer in internal rotation. Fair power regained in musculospiral nerve. Passive movements normal, except extension of shoulder, which is absent. He can get his hand to his mouth in full supination (Fig. 9, A).

April 16, 1915: Humerus remains reduced. Gets hand to mouth very well. Very little disability.

February 21, 1916: Humerus remains reduced. External rotation normal. Deltoid feeble. Cannot raise hand above nor behind head. Can put hand to mouth, but not in *full* supination. Passive abduction in shoulder 60 degrees. Some weakness still in extensors of wrist and fingers. Triceps and biceps good. Supination: active, one-half normal; passive, normal. Does not use the arm very much.

March 13, 1917: Mother reports that child died from appendicitis in January, 1917. She says the arm was "just grand."

CASE X.—*Subspinous dislocation of humerus, deformity of elbow, and wrist drop; arthrotomy of shoulder; excision of head of radius, arthrodesis of wrist by bone transplant.* George W. was fifteen years of age when he came to the Episcopal Hospital May 24, 1914. He had three brothers and two sisters living and well. His right shoulder had been injured in birth, and his arm was practically useless.

Examination.—His right arm hangs in internal rotation, the humerus abducted, the elbow flexed, the forearm in pronation. The head of the humerus is absent from its normal site in front of and below the acromion and is visible and palpable below the spine of the scapula. Passive movements: these are normal in the fingers and hand, and in the wrist, except adduction at the wrist which is lost. Extension of the elbow to 145 degrees, and flexion to 50 degrees. Complete pronation and supination are both lacking, rotation being present only through an arc of 30 degrees, most limited in supination. The head of the radius is prominent beneath instead of anterior to the external condyle, being luxated posteriorly. At the shoulder abduction of the humerus is possible through an arc of 60 degrees, flexion through 45 degrees, and extension through 20 degrees. External rotation at the shoulder is possible until the flexed forearm just passes the sagittal plane. Internal rotation when the humerus is abducted is similarly limited just before the forearm reaches the coronal plane. The motions of the scapula are not limited. The head of the humerus is dislocated posteriorly beneath the spine of the scapula. The acromion is prominent, with its upper flat surface looking outward, being twisted through an arc of 45 degrees. The clavicle is subluxated upward. The coracoid is normal. Active movements: he has scarcely any grip in his hand; there is slight power in the lumbricals and interossei, fair power of flexion of the thumb, very little adduction of thumb. The wrist cannot be actively extended (Fig. 13, B), but if hyperextended passively it can be held weakly in extension momentarily (Fig. 12). There is no power of rotation in the forearm. The elbow can be actively extended to 145 degrees, and flexed only to 70 degrees (passive flexion possible to 50 degrees). At the shoulder there is active but weak abduction of about 30 degrees, flexion of 30 degrees (secured solely by rotation of the scapula), and no extension, no external rotation, but good internal rotation. The axillary fold muscles are good, and there is fair power in the deltoid. The triceps is good. He cannot get his hand to his mouth, it being impossible for him to raise his arm higher than the plane of his shoulders.

Operation (May 31, 1914).—Senn's incision, temporary resection

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of the acromion. The bicipital groove was found directly in line with the external condyle of the humerus, apparently owing to the gradual internal rotation of the shaft of the humerus below the tuberosities. Section of the tendon of the subscapularis at once allowed external rotation of the arm until the forearm was in the coronal plane. It was still impossible to secure complete reduction of the dislocated head of the humerus, owing to tenseness of the pectoralis major. The tendon of this muscle was then divided through another incision (in the line of the anterior axillary fold), and at once easy reduction of the head was secured by external rotation, abduction, and slight pressure forward on the head. If abduction was carried too far the humerus again luxated posteriorly and upward (tension on teres major?). The most stable position was in abduction of 70 degrees and external rotation about 20 degrees short of the coronal plane. The outer end of the clavicle, which was luxated upward, was excised, and this allowed the acromion to come back into better position; but the tip of the acromion was so far bent downward that it kept the head of the humerus pushed backward. Therefore a wedge-shaped piece (base upward) was cut off the portion of the acromion temporarily displaced (not from the spine of the scapula), so that when the remaining portion of the acromion was replaced against the spine of the scapula, the tip of the acromion no longer interfered with the proper position of the humerus, but rode above it. The acromion was fixed against the scapula with a screw. The muscles and skin were sutured separately with interrupted sutures of chromic gut, and the arm was dressed in plaster of Paris in abduction of about 70 degrees and external rotation almost to the coronal plane (Fig. 12).

First dressing six weeks later, when another cast was applied and worn until three months after operation. It was next decided to operate on the elbow, as pronation and limitation of extension persisted and were evidently due to the dislocation of the head of the radius.

Second Operation (October 14, 1914).—Kocher's external incision. The brachioradialis and extensor carpi radialis were detached from the supracondylar ridge and pushed forward, and the anterior surface of the capitellum was exposed. The external lateral ligament was then cleared and the head of the radius was exposed in front of it. The head luxated posteriorly in extension of the elbow and limited further extension. The neck of the radius was divided by a Gigli wire saw, and the head removed. This allowed 20 degrees more of extension. The anterior capsule of the elbow-joint was next divided, and then the anterior tendinous surface of the brachialis anticus, its muscle fibres readily yielding to extension when once the aponeurosis was divided. Complete extension was not even yet possible, so the olecranon was exposed behind the external lateral ligament, by displacing the triceps backward, and its tip was cut off (1.25 cm.) by osteotome. Extension to 170 degrees was now possible. The wound was closed in layers, and the arm dressed on an internal angular splint.

November 30, 1914: Passive motion in elbow 65 to 145 degrees. The wrist is no stronger than at first examination, but he now has a fair grip in his hand. He cannot flex his elbow actively beyond 90 degrees, and cannot get his hand to his mouth.

December 7, 1914: Brace applied to overcome wrist drop.

January 25, 1915: Elbow, passive movements, 65 to 155 degrees; active, 85 to 155 degrees. Shoulder movements are more free than before operation, and chief disability now is from wrist drop.

Third Operation (March 3, 1915).—Curved incision over extensor surface of wrist, slightly convex to ulnar side, from base of index metacarpal to 3 inches above wrist-joint. Annular ligament incised between thumb and index extensors, opening wrist-joint. Radius bared of periosteum. With twin circular saw a slot (6 to 7 mm. in width) was cut in extensor surface of radius, across carpus (scaphoid, trapezoid, and os magnum) and in adjoining surfaces of index and middle metacarpal bones. The slot was cleared of bone with chisel and gouge forceps; all fragments were preserved. A transplant of corresponding width and length was then cut from the subcutaneous surface of left tibia, and inserted in the groove at the wrist. Six transverse saw cuts were made in the transplant so as to allow it to be bent to permit slight hyperextension of the wrist. It was fixed in place by suturing periosteum and fascia over it, with No. 3 chromic gut. The fragments removed from the wrist were then inserted in the defect in the tibia, and both wounds closed. The wrist was dressed on a palmar splint of gypsum in slight hyperextension.

March 15, 1915: Returns to Dispensary for dressing.

March 22, 1915: Good union in wrist. Incision healed.

April 12, 1915: Skiagraphs show transplant in good position, and leg filling in with fragments transplanted from wrist. Gypsum splint continued.

May 24: Binder's board splint applied. Wrist has lost its hyperextension, but remains at 180 degrees.

June 28: Carries objects in hand, dresses himself, and can hold his French horn better. (He plays in an orchestra.)

July 26: Can now close all fingers but fifth. Improvement is marked.

October 5: A few days ago he broke his transplant in the wrist, while asleep, in turning in bed. This allows motion in the wrist of 30 degrees (180 to 150 degrees). Hand continues to grow more useful.

October 14, 1915: Skiagraph shows transplant incorporated with radius and ankylosed to the index metacarpal.

March 12, 1917: Nearly three years after first coming under observation: He finds his hand perfectly useful in playing the French horn. (It should be mentioned that the French horn is played by the left hand, and that the right hand is placed in the flaring end of the horn to support its weight, etc.) He has practically normal use of the thumb, index and little fingers. The fourth and fifth fingers have very little power. There is passive motion at the wrist from 170 to 140 degrees, flexion being possible actively, but there being no active power of extension (Fig. 13). Pronation in the forearm is complete, both passively and actively; supination, actively and passively, is possible to the midposition; that is to say rotation has increased from a range of 30 degrees when first seen to a range of 50 degrees or more at present. There is passive motion at the elbow from 60 to 160 degrees, and active motion from 90 to 160 degrees. At the shoulder passive abduction is 60 de-

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grees, and active 45 degrees; passive flexion is 90 degrees and active flexion 60 degrees. He is still unable to get his hand to his mouth or to the small of the back.

Compared with his condition when first seen, his present condition is markedly improved; both his parents and himself are satisfied.

CASE XI.—*Disability from contractures; open tenotomies.* Joseph V. was brought to the Episcopal Hospital when twelve years old, April 19, 1915, for disability persisting from an injury to the right shoulder region during birth. He had four sisters, none of them injured in birth, and one brother, who had died of unknown cause (no birth injury).

Examination.—He carries his arm in internal rotation, and he cannot put his hand to his mouth nor behind his head. He cannot flex his elbow beyond 90 degrees nor can he fully extend it. Rotation in the forearm (active and passive) is limited in both supination and pronation. Passive movements in the elbow and wrist are not limited. There is passive external rotation at the shoulder only to the sagittal plane; there is no passive extension of the shoulder; passive abduction is possible almost to 90 degrees, but only with the arm anterior to the coronal plane (in partial flexion). Active movements of the hand and fingers are normal. There is good active flexion of the shoulder (by contraction of the coracobrachialis and pectoralis major), but no active extension nor abduction. There is no posterior dislocation of the humerus. The end of the clavicle is slightly above the level of the acromion.

It was recommended that the limitations to external rotation and abduction at the shoulder be overcome by a series of plaster casts. This was declined by his parents, and the boy was not seen again for almost a year (March 13, 1916). No improvement had occurred, and operation was recommended and accepted (Fig. 14, A). Re-examination shows slight posterior subluxation of the humerus.

Operation (March 20, 1916).—Ether. Incision as for excision. Division of tendon of pectoralis major allowed normal abduction. The latissimus dorsi was not tight in abduction. Division of the tendon of the subscapularis, while it was kept under tension by attempts to secure external rotation, allowed suddenly full external rotation. This incision passed through the joint capsule, making the head of the humerus visible, and causing it to tend to luxate anteriorly; but even in full external rotation and abduction it did not actually luxate. The bicipital groove seemed displaced externally, looking outward rather than forward. Wound closed without drainage and arm dressed in full abduction and external rotation in plaster of Paris.

March 25: Went home.

May 5: New case applied.

June 9: Case removed. Ordered massage and passive motion.

June 25: Can put cap off and on.

March 7, 1917: One year after operation. Gets hand to mouth easily in supination, but arm still abducts slightly in this movement (Fig. 14, B). Uses right hand now in writing (formerly used left). Active external rotation is possible to 60 degrees beyond the sagittal plane (Fig. 14, C), passive external rotation perhaps 10 degrees further.

Active abduction is possible through an arc of 60 degrees, passive abduction perhaps 10 degrees further.

CASE XII.—*Disability from contractures; open tenotomies.* William L. came to the Episcopal Hospital November 23, 1914, at the age of eleven years. His right arm had been injured in birth, and great disability persisted.

Examination.—Carries arm in internal rotation and cannot get hand to mouth; even with the aid of the left hand he can get his right hand to his mouth only with wide abduction of the humerus, and with the hand in full pronation. His hand is practically useless. There is atrophy of the supra- and infraspinatus muscles, of the biceps and triceps; and marked contractures of the pectoralis major, the subscapularis, and to a less disabling degree, of the latissimus dorsi. Passive external rotation is impossible beyond the sagittal plane. Extension of the elbow is limited.

Operation (December 9, 1914).—Ether. Incision as for excision of shoulder. Subscapularis was divided at its insertion into the lesser tuberosity; this at once allowed external rotation to the coronal plane. Then the tendon of the pectoralis major was lengthened by the usual method of tendon lengthening, known as Z-plasty, the lower half of the insertion being divided close to the humerus, and the upper half of the tendon being cut about 3 cm. nearer the chest. Thus fully one inch lengthening was secured. Dressed in the usual position (abduction and external rotation) in plaster of Paris.

December 15: Went home.

January 22, 1915: Six weeks and a half after operation: case removed.

February 1: Cannot get hand to mouth in supination. Ordered massage and passive motions.

February 8: Learning to write with his right hand (previously used left hand). Can easily put hand to mouth in supination, and to the top of his head. The improvement was most striking.

March 22: Can put hat off and on, and put hand to back of neck.

May 24: Very good use of hand. Still tends to abduct humerus in flexing elbow. Passive external rotation of the humerus is as good as on the left.

December 6, 1915: Uses hand for everything. Good grasp. Full extension of the elbow. Active external rotation to the sagittal plane.

January 17, 1916: Almost complete active supination.

February 12, 1917: There is power in the deltoid. Can hold his hand above his head. There has been continued improvement during the year.

CASE XIII.—*Flaccid paralysis of shoulder (right) with flail joint; transplantation of pectoralis major to supplant deltoid; of pronator radii teres to become supinator, and of flexors of carpus to become extensors.*—Carl C. was thirteen years of age when he was brought to the Episcopal Hospital, October 20, 1913. He is the first child of his parents; the second and fifth children died at birth, but the third and fourth children are normal. This patient was born by instrumental delivery (head presentation), and his right shoulder was injured during the process. He was treated by massage and electricity

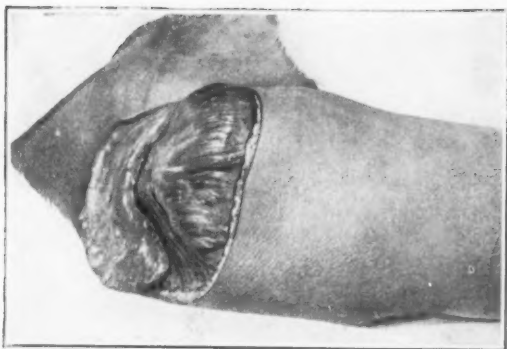


FIG. 1.—Curved incision around acromion, flap of skin turned up.

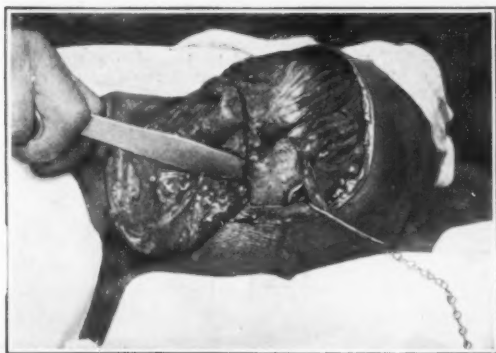


FIG. 2.—Spine of scapula exposed and retractor passed under base of acromion.



FIG. 3.—Acromion divided at its base and turned forward. The long tendon of the biceps is clearly exposed; in front of it the subscapularis just comes to view; posteriorly the supraspinatus and infraspinatus muscles are seen.



FIG. 4.—Case II. Subspinous dislocation of right humerus; patient aged three months. Note that on the injured side (arm held close to body in internal rotation) the epiphysis of the head of the humerus is far removed from the glenoid.



A



B

FIG. 5.—Case II. A, aged six months; B, aged three and one-half years.



A

B

C

FIG. 6.—Three sisters with birth injuries of shoulders. (Fourth child killed in delivery.) A, child aged three years, dislocation of left shoulder; B, child aged six years, right shoulder (no dislocation); C, child aged seven years, dislocation of left shoulder.



A



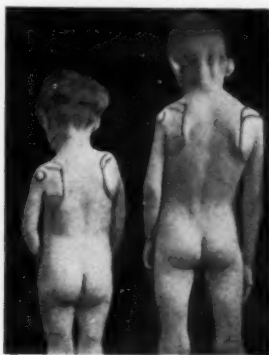
B

FIG. 7.—Case VI. *A*, child aged five years, posterior dislocation of right shoulder from injury at birth
B, eight months after operation.



A

B



A

B

FIG. 8.—Cases VII and IX. Birth injuries of left shoulders. *A*, child aged four years; *B*, child aged seven years.



A

B

FIG. 9.—Cases VII and IX. Seven months after operation. *A*, "bloody"; *B*, "bloodless."



A



B



C



D

FIG. 10.—Case VIII. Child aged five years. Subspinous dislocation of left humerus. A, rear view; B, front view; C, attempt to put hand to mouth; D, after operation, dressed in the usual position.



FIG. 11.—Case VIII. Child aged seven and one-half years. Birth injury of left shoulder. Two years after open operation.

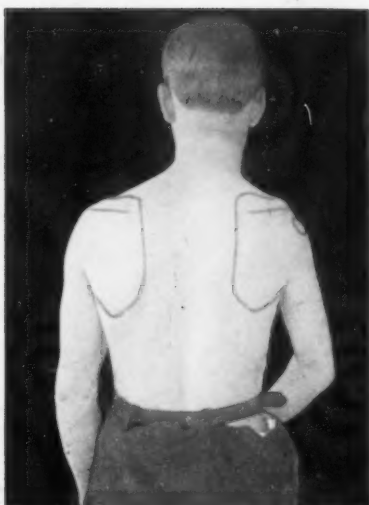
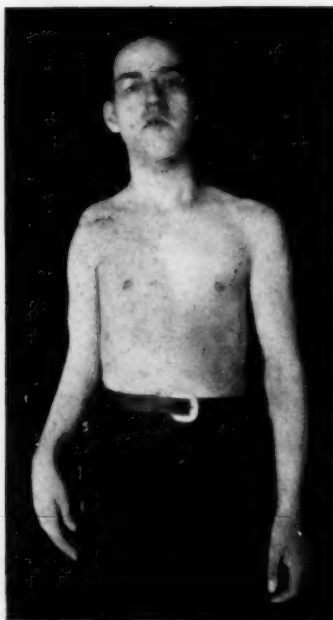


FIG. 12.—Case X. Patient aged fifteen years. Subspinous dislocation of right humerus. After reduction the arm was dressed in the most stable position.

A



B



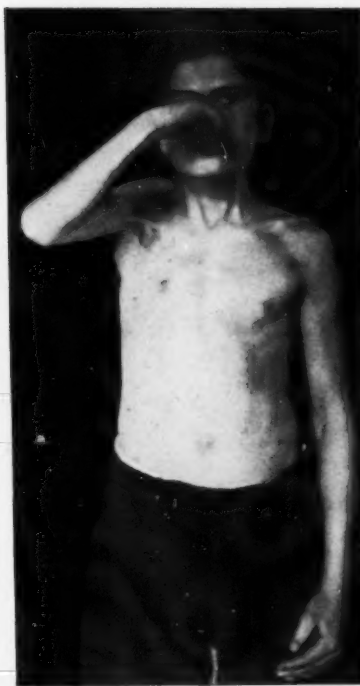
C

FIG. 13.—Case X. A, photograph made September 21, 1914, four months after operation on shoulder; external rotation restored (compare with Fig. 12). B (February 15, 1915) and C (March 3 1916), hand and wrist before and after arthrodesis.

A



B



C

FIG. 14.—Case XI. Showing marked improvement in function secured by tenotomies. A, March 20, 1916; B, one year after operation; C, March 14, 1917, one year after operation.



A



B

FIG. 15.—Case XIII. Brachial birth palsy of right upper extremity, with flail shoulder, and loss of supination in forearm and of extension in wrist. A, disability before operation; B, result four months after operations.



FIG. 16.—Case XIII. Showing the incision employed for transplantation of pectoralis major to take the place of the paralyzed deltoid. Before this operation the humerus became subluxated anteriorly when the position shown in the photograph was assumed, and the arm could not be drawn forward without the aid of the left hand. Voluntary flexion of the shoulder-joint is now easy.

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from the age of seven weeks to that of one year. Since that time nothing had been done, and his parents were now anxious to know if something could not be done to lessen his disability.

Examination.—He carries the right arm rotated in, the elbow flexed, and the forearm pronated. The limb is useless. Passive movements were possible as follows: Shoulder can be abducted to 60 degrees; can be rotated externally about half the normal extent; while flexion and extension in the shoulder are normal. Flexion in the elbow is normal, but extension is very slightly limited. Wrist motions are normal. Supination beyond the mid-position is impossible. Active motions are as follows: scarcely any motion in shoulder, but the axillary fold muscles are good. The biceps and triceps have fair power. There is no active supination; no power in the extensors of the carpus; extensors of the fingers are good, flexors of the carpus and the fingers are good. He can put the back of his hand to his mouth, but not the fingers, owing to the persistent pronation (Fig. 15, A). Whenever the arm gets back of the plane of the body the humerus luxates forward at the shoulder-joint and it remains luxated anteriorly until with his left hand he pulls the paralyzed arm forward into a position of flexion and adduction. This causes great disability, and is evidently due to the complete paralysis of the deltoid. Limitation of external rotation at the shoulder and persistent internal rotation indicate there is no paralysis of the internal rotators.

The treatment proposed was to secure supination of the forearm and to prevent the recurrent anterior luxation of the shoulder.

Operation on Forearm (August 27, 1913).—Esmarch band above elbow. The pronator radii teres was transplanted through the interosseous space around the posterior and external surfaces of the radius, and while the forearm was maintained in full supination (which became possible after section of the teres muscle) it was sutured to the lateral and flexor surfaces of the radius, the sutures being passed through drill holes in the radius. Next the flexor carpi radialis was transplanted (superficial to the thumb extensors) into the extensor surface of the base of the index metacarpal. Finally the flexor carpi ulnaris was transplanted to the extensor surface of the carpus (unciform or cuneiform bone). The arm was dressed on an anterior angular splint, with the forearm in full supination and the wrist hyperextended.

September 17: First dressing: all incisions healed. Can carry hand to mouth in supinated position. Wrist stays hyperextended.

Operation on Shoulder (September 24).—Incision from third costal cartilage to sternoclavicular joint, along clavicle to acromion, thence down outer surface of shoulder nearly to insertion of deltoid (Fig. 16). This large flap was turned down and the clavicular and upper sternal fibres of the pectoralis major were cut at their origin, and, with care to preserve their nerves and vessels, these portions of the muscle were shifted out over the paralyzed deltoid and were sutured to a groove cut by Hey's saw in the acromion and outer third of the clavicle. The incision was closed without drainage. A continuous linen suture was employed for the skin. The limb was put up in plaster of Paris, in abduction and external rotation, with the forearm still in full supination.

October 4: Went home.

October 20: Sutures removed through opening in case. Incision healed.

November 3: Case removed, six weeks after operation. Arm carried in sling. Massage ordered.

November 10: Sling removed. Passive movements ordered.

November 24: Can put hand to mouth in supination well. When arm is put behind back he can pull it forward easily by action of transplanted pectoralis major. He can actively extend the wrist, but there is still a tendency to ulnar deviation of the hand.

December 8, 1913: To go to school. Can take hat off and on with his right hand.

December 15: Slight active supination. Photograph in Fig. 15 shows his present condition.

December 27: Can cut his meat with his right hand.

January 17, 1916 (two years later): Works as messenger boy. Can button coat with right hand; can with difficulty get hand to back of head and to mouth(but not in supination). Wrist is in ulnar deviation. He can actively flex and extend wrist and fingers. Active supination is weak. The biceps is good (formerly very feeble). The head of the humerus is in position. There is no active abduction, but he can carry arm forward in sagittal plane (flexion of shoulder) by contraction of the transplanted pectoralis major, which can be felt contracting well.

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PULSE RATE AND BLOOD-PRESSURE OBSERVATIONS AS AN AID IN THE TREATMENT OF HEAD TRAUMAS

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It is a recognized clinical fact that a rapid encroachment upon the intracranial space by any foreign body is frequently associated with a slow, high tension pulse. This phenomenon has been an almost uniform accompaniment of artificially produced cerebral compression in the laboratory experience of many investigators.

As the brain tissue is practically incompressible and is enclosed in a non-expansible skull box, the introduction of an intracranial foreign body is only possible through the emptying of the surrounding vascular channels.

In 1902, Cushing¹ produced, experimentally in dogs, a general cerebral compression, by allowing normal salt solution, warmed to body temperature, to enter the cranial space through a cannula screwed into a trephine opening in the arch of the atlas. The tension of the fluid was regulated by the degree of elevation of a pressure flask and was recorded on a revolving drum simultaneously, and in exactly the same way as the arterial pressure. Direct observation of the cortical circulation was made through a circular disc of glass with a bevelled edge, made to fit a large trephine opening near the mid line, so as to expose the longitudinal sinus, as well as the surrounding pial vessels. The rate and excursion of the respiratory wave was also recorded on a revolving drum with the intracranial and arterial pressures. In this way observations were made on the effect that various degrees of intracranial pressure had upon the respirations and general circulations, as well as the vascular alterations of the brain itself. When the pressure of the fluid in the intracranial space was allowed to increase, there was first noted a distinct evidence of venous stasis, with bluing of the exposed convolution and later a narrowing of the longitudinal sinus. As the intracranial tension approximated the arterial pressure a condition of anæmia was produced as shown by the blanching of the cortex, the veins remained filled with blood and very little if any circulation was evidenced. As the pressure produced is a general one, a similar anæmia is present in the medulla, where the vital centres are poorly nourished, if at all. This anæmia of the medulla stimulates the vagus centre, slowing the pulse, and likewise the vasomotor centre, resulting in an increase in the general arterial pressure to a point above that of the high tension in the intracranial space. The pale cortex becomes pink and the respirations, which are very irregular, or perhaps have ceased entirely, are again resumed as a result of the return of blood to the respiratory centre. If, after this readjustment of circulation

¹ American Journal Medical Sciences, 1902, vol. 124, p. 375-400.

has taken place, the intracranial pressure is again increased to a point above that of the arterial pressure, anæmia is again produced and the blood-pressure once more rises in its turn, to the point of exceeding the intracranial tension. Thus the process may be continued until the arterial pressure is raised to a point two or three times its normal level, in an attempt to exceed the intracranial pressure and supply normal nutrition to the bulbar centres. With the continued increase of the intracranial tension, sooner or later a time comes when the vasomotor centre weakens and is no longer able to supply sufficient blood to the medulla. The blood-pressure falls below that of the intracranial tension and the animal dies with a low blood-pressure and rapid pulse, which may continue for some time after the respiration has ceased, a typical respiratory death.

In order to determine whether this physiological response represented a regulatory mechanism which controls the rise in blood-pressure, or is nothing more than some uncontrolled reaction from irritation of the vasomotor centre, he first eliminated the inhibitory action of the vagus centre by dividing both vagi. Under these conditions, the blood-pressure and degree of intracranial tension followed one another with the same regularity as before, the blood-pressure always tending to remain slightly above that of the tension in the intracranial space. If at the same time a loop of bowel was exposed, the calibre of the mesenteric vessels was seen to diminish during the great rise in blood-pressure and to dilate if the tension upon the brain was released. Again, if the vasomotor control was eliminated by division of the spinal cord above the level of the sympathetic nerves to the abdominal viscera, only the slowing of the pulse was produced, with no increase whatever in the arterial pressure. Cushing's experiments, therefore, tend to show that if tension in the intracranial space is rapidly increased there is produced an anæmia of the brain and medulla. As a result of the approaching medullary anæmia, there is a physiological response represented by a rise in arterial pressure to a point above that of the intracranial tension. In this way a fatal medullary anæmia, which otherwise would be the result of an equalization of the intracranial and arterial pressure, is warded off. The mechanism of this response is attributed to the vasomotor control of the large splanchnic area, which holds the arterial pressure slightly above that in the intracranial space. With exhaustion of the vasomotor mechanism there is an equalization of the intracranial and arterial pressures, following which there is a fall in blood-pressure and respiratory failure in consequence of the resulting bulbar anæmia. Hill,² Duret,³ Cybulski⁴ and others have shown that death is not produced until the intracranial pressure equals or exceeds the arterial pressure.

In cerebral trauma several theories have been advanced to explain the

² *Physiology and Pathology, Cerebral Circulation*, London, 1896.

³ *Etude experimentale et clinique sur les traumatismes cerebraux*, Paris, 1878, p. 186.

⁴ *Centralblatt fur Physiologie*, 1890, * 835.

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progressive increase in intracranial tension to such a degree that the pressure in the cerebral vessels is overcome and anæmia results. Hill⁵ and Bergmann⁶ state that as a result of a local increase in intracranial tension there is a complete stasis of blood in the obliterated area. This produces an increased pressure in the vessels of the surrounding areas and causes a transudation of plasma from the capillaries, thus increasing the volume of the compressing body. In this way a vicious circle is established, so that the anæmia may advance until the bulbar centres are encroached upon. According to Courtney,⁷ traumata resulting from blows paralyze the cerebral vasomotor centres. This paralysis results in a dilatation of the vessels which they control, producing arterial stasis with a rise in intracranial venous pressure, thrombosis and transudation. As the transudation cannot be absorbed, because of the high pressure in the veins, it further impedes the circulation until complete anæmia results. Cannon⁸ attributes the intracranial tension to œdema. Pathological changes are brought about which result in an impairment of the nutrition of the injured area. As a result the tissues undergo changes, producing an increase of the internal osmotic pressure and therefore an increase of water content. The œdematous region compresses the blood-vessels in the surrounding areas, nutrition is again impaired and the osmotic pressure increased, producing further œdema. In this way, the œdema spreads until the cerebral circulation is so encroached upon that anæmia results.

Whatever the correct physiological explanation may be, for an increase in intracranial pressure following cerebral trauma, the agreement is quite universal that fractures of the skull are often accompanied by an increase in intracranial tension and furthermore that this tension frequently rises to such a height that the cerebral vessels are compressed, resulting in anæmia and death. By injecting wax into the cranial cavity, Duret⁹ has shown that decreasing the intracranial space by 5 per cent. produced coma and by 8 per cent. resulted in death.

The symptoms resulting from fracture of the skull vary greatly with the severity and location of the intracranial injury. Any force sufficient to break the skull rarely, if ever, fails to injure its contents. Whether or not there is produced gross laceration, contusion or compression, there is at least a change in the physical structure of the brain. The fracture itself, unless depressed, is of very little consequence, so much so that if it were not for the associated intracranial complications, the treatment of this serious injury would be simple. During the past five years in all head

⁵Loc. cit., p. 188 et seq.

⁶Deutsche Chirurgie, Die Lehre von den Kopfverletzungen, Stuttgart, 1880, ZZZ, p. 420.

⁷Boston Med. and Surg. Journal, 1899, cxi, p. 347.

⁸American Journal of Physiology, 1902, vi, pp. 103-121.

⁹Etude expérimentale et clinique sur les traumatismes cérébraux, Paris, 1878, p. 86.

injuries we have followed very closely the pulse rate, respiration and arterial pressure, as well as the other symptoms. In many instances, there has been a striking similarity between the symptoms preceding death in cases of fracture and those produced in animals by increasing intracranial pressure to the point of cerebral anæmia. In most cases there has been a history of a fall or blow on the head, producing unconsciousness. If consciousness returns it is frequently lost again, gradually passing into deeper and deeper stupor, then coma from which the patient cannot be aroused. By closely observing the pulse rate and arterial pressure at ten to fifteen minute intervals with the increasing stupor there is observed a slight but definitely progressive increase in the blood-pressure and decrease of the pulse rate. If the injury of the cranial contents is severe enough to cause a great increase in the intracranial pressure, there is produced the characteristic high tension, slow pulse. In the final stage certain typical signs manifest themselves. As the time of death approaches there is stertorous or perhaps Cheyne Stokes breathing, the temperature rises, the reflexes disappear and the patient becomes relaxed. The blood-pressure gradually falls to zero and respirations cease, leaving the running pulse of a vasomotor failure to end the story. The vasomotor mechanism has been unable to maintain the blood-pressure above the intracranial tension and supply sufficient blood to the respiratory centre.

The mortality in fractures of the skull treated by the time-honored expectant method is very high. We believe that frequently death is the result of medullary compression and œdema and that the degree of encroachment upon the vital centres may be ascertained by frequent observations of the pulse rate and blood-pressure. In such cases early relief of pressure is advisable not only to save life, but to lessen the danger of numerous nervous disturbances so frequently seen following fractures of the skull. Not all cases have an associated intracranial tension great enough to produce medullary compression. In some there is sufficient escape of blood and cerebrospinal fluid through a line of fracture to relieve an otherwise fatal compression. These cases do not show the high tension, slow pulse so characteristic of approaching medullary compression, and so operative interference is neither necessary nor advisable. In other cases, the associated laceration or contusion of the brain may be so extensive that a relief of pressure not only fails to avert a fatal outcome, but is an added shock, usually hastening death. There is a group of cases mid-way between these mild and severe types, in which there occurs a progressive increase of intracranial pressure. Unless there is early relief of the tension a fatal outcome is a certainty. We believe that with care this group of cases may be properly differentiated by frequent blood-pressure and pulse rate observations. From these observations one may not only determine the degree of cerebral compression but they may be utilized as an indication for or against the necessity of operation. We do not wait for the appearance of any certain degree of cerebral compression as an indication for operative inter-

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ference. Whenever a case of head injury shows a progressive increase in arterial pressure and a corresponding decrease in pulse rate, it is not only advisable, but imperative that immediate relief of intracranial pressure be instituted. If the pressure is not relieved before the dangerous stage of medullary compression occurs, shown by a falling blood-pressure and increasing pulse rate, so much cerebral damage may have been produced that recovery is doubtful.

Barnes and Slocum¹⁰ advise daily lumbar punctures for relief of pressure in fractures of the skull and report a decrease in the mortality during the past three years as corresponding with the previous three years. We have made very little use of lumbar puncture therapeutically, but employ it more as a diagnostic aid. We have frequently observed little or no increase in the pressure of the fluid within the spinal sac, but in the same case at time of operation an enormous increase of intracranial fluid was found. These findings may be explained by a dislocation downward of the brain, blocking the foramen magnum and shutting off the spinal fluid from the effects of tension existent within the cranial cavity.

Whenever relief of intracranial pressure is indicated we have always employed the subtemporal decompression. As most fractures of the skull involve the middle fossa, by this method the meningeal vessels as well as the area where pressure is most dangerous may be directly exposed. The opening in the skull should be large, having a diameter of 4-6 cm. and extend down to the floor of the middle fossa to secure free drainage of blood and cerebrospinal fluid. The temporal muscle and fascia give a firm closure and prevent subsequent herniation.

We have had the opportunity of observing and treating a series of 76 cases of fracture of the skull resulting from acute head injury. Of these cases, 46 were classified as compounds and 30 as simple fractures of the skull. In 17 cases the base alone was fractured and in 22 the vault, while in the remaining 37 cases both the vault and base were involved. The total number of deaths was 26, making a total mortality of 34.2 per cent. Many of the patients who died when first seen were in a moribund condition, having not only a severe head injury, but also other injuries, such as rupture of large viscera and fracture of long bones. If we exclude those patients who died within four hours after admission to the hospital, the total mortality would be 20.6°.

Great emphasis has been placed upon the pulse rate and arterial pressure in the treatment of these cases, although the other symptoms of compression were closely followed. From these observations we have divided our cases into three groups: First, those cases which at no time show any evidence of intracranial pressure; second, cases presenting signs of a definite increase of more or less degree in the intracranial pressure, and, third, those cases which present symptoms of advanced medullary compression or in which there is evidence of severe laceration or contusion of the brain. In the

¹⁰ New York Medical Journal, 1916, vol. 103, p. 309.

first group there were 27 cases. (See Table I.) As in this group there was at no time any evidence of an increase in intracranial pressure, surgical interference was indicated only when the fragments were depressed. We believe that if all depressed fragments are elevated, the danger of many post-traumatic neurological conditions could be greatly decreased. The prognosis as to life is very good in this group, providing infection of meninges and brain tissue is avoided in those cases where the fracture is compound.

TABLE I

GROUP I

Hospital Number	Age	Sex	Operation	Pulse rate and blood-pressure		After operation		Result
				P.	B. P.	P.	B. P.	
M-76	6	M.	None	108	108	..	...	Well.
101	9	M.	None	84	95	..	...	Well.
M-134	34	M.	Elevation of fragments. Removal of bullet	80	110	85	118	Well.
176	45	M.	None	75	115	..	...	Well.
M-610	12	M.	None	90	125	..	...	Well.
M-634	23	M.	None	92	124	..	...	Well.
507	43	M.	None	88	125	..	...	Well.
178	3	M.	None	140	98	..	...	Well.
187	31	M.	None	100	130	..	...	Well.
286	21	M.	None	90	115	..	...	Well.
359	33	M.	None	78	125	..	...	Well.
465	5	M.	Elevation of fragments	108	92	90	No record	Well.
794	4	M.	None	108	100	..	...	Well.
950	48	M.	Elevation of fragments	No record	...	No record	...	Well.
1153	9	F.	Removal of bullet	84	95	No record	...	Well.
1249	35	M.	None	92	110	..	...	Well.
1603	35	F.	None	84	105	..	...	Well.
1848½	7	M.	Elevation of fragments	90	120	..	...	Well.
2085	61	M.	None	90	135	..	...	Well.
2089	55	M.	None	80	138	..	...	Well.
2388	6	M.	None	85	102	..	...	Well.
2495½	5	F.	None	156	95	..	...	Well.
2308	39	M.	None	72	110	..	...	Well.
2504½	28	M.	None	88	135	..	...	Well.
2805	7	M.	None	110	105	..	...	Well.
2994	35	M.	None	110	122	..	...	Well.
2479	2	F.	None	120	80	..	...	Well.

In five cases operative interference was necessary and of the entire group all made good recoveries.

It is in the second group, those patients presenting signs of a definite increase of intracranial pressure, that we find blood-pressure and pulse rate observations most useful. We believe the degree of pressure as well as the importance as to whether or not the pressure present is increasing may be determined in most cases by frequent pulse rate and arterial tension observations. Thus, these observations are utilized not only to determine the degree

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of intracranial pressure, but also as an indication for or against the necessity of operation. If a rapidly increasing intracranial pressure can be relieved before it produces serious damage to the brain, in most cases a fatal issue may be avoided. In some cases the intracranial pressure produced by the

TABLE II
GROUP II

Hospital Number	Age	Sex	Operation	Pulse rate and blood-pressure		After operation		Result
				P.	B. P.	P.	B. P.	
706	44	M.	Decompression	54	178	120	125	Death, 24 hours.
1813½	29	M.	Decompression	64	142	No record	...	Good recovery.
160	43	M.	Decompression	70	164	No record	...	Good recovery.
133	40	M.	Decompression	75	180	100	128	Good recovery.
550	17	M.	Decompression	80	145	132	110	Good recovery.
770	37	M.	None	68	135	...	...	Good recovery.
1021	27	..	Decompression	70	145	108	100	Good recovery.
1354	4	M.	None	78	135	...	...	Good recovery.
1368	66	M.	None	60	165	...	...	Good recovery.
1404	56	F.	None	60	150	...	...	Good recovery.
1379	59	M.	Decompression	66	165	84	110	Death, 22nd day, pneumonia.
1544	65	M.	Decompression	70	172	80	124	Good recovery.
1631	35	M.	None	74	152	...	...	Good recovery.
1347	23	M.	Decompression	54	180	104	110	Death 7th day Streptococci meningitis.
119	31	M.	Decompression	50	194	No record	...	Death, 1 hour after operation.
78	54	M.	Decompression	70	148	120	110	Death, 23rd day, pneumococci meningitis.
70	28	M.	Decompression	52	160	102	135	Death 36 hours after operation.
2503	12	M.	None	60	138	...	...	Good recovery.
347	40	M.	Decompression	62	164	120	130	Death 1 hour after operation.
2596	28	M.	Decompression	50	160	90	115	Good recovery.
2090	13	M.	None	70	135	...	...	Good recovery.
2336	68	M.	Decompression	76	155	110	120	Death, 33rd day, pneumonia.
728	8	M.	Decompression	66	135	No record	...	Good recovery.
12	12	M.	Decompression	70	152	No record	...	Good recovery.
264	39	M.	Decompression	42	150	No record	...	Death, 48 hours after operation.
2761	24	M.	Decompression	44	146	60	120	Good recovery.

injury may never reach a degree sufficient to endanger the life of the patient, while in others a fatal compression of the medulla may occur so rapidly that relief cannot be given. Twenty-six, or 34.2 per cent., of our cases presented signs of an increased intracranial pressure, accompanied by an elevation in the blood-pressure and slowing of the pulse rate. (See Table II.) In 19,

or 73 per cent. of these, the pressure reached such a degree as to endanger the life of the patient and operation was necessary. Ten of the nineteen cases operated upon made good recoveries. Of the nine deaths, two were the result of pneumonia and two died of meningitis. In each of these cases pressure was relieved by operation and they gave every promise of recovery until infection occurred. The patients dying of meningitis—in Case 1379 there was an extensive wound entering the nose and frontal sinus, from which a pneumococci infection of the meninges occurred resulting in death on the twenty-second day. Case 1347 had a very dirty compound wound, and, although every precaution was taken to avoid infection, he succumbed to a streptococci meningitis on the seventh day. In the remaining five cases decompression did not avert a fatal outcome, although at operation all showed evidence of a high grade of intracranial pressure. That there is a fall in blood-pressure and return of pulse rate to normal, as well as marked improvement in general condition, after a high intracranial tension has been relieved can be noted from the post-operative pulse and blood-pressure observations.

Surg. No. 2596. *Simple linear fracture of the skull, vault and base. Intracranial hemorrhage; severe compression symptoms. Subtemporal decompression. Recovery.* This patient, a young man, 28 years old, was admitted to the hospital with the history of falling from a ladder, a distance of ten feet, striking the pavement and injuring his head. When seen in the emergency ward, one hour after the injury, he was semi-conscious, very restless, irritable and screaming in a foreign language. He was unable to give his name or answer any questions intelligently. Bloody cerebrospinal fluid was escaping from his right ear. The pupils were moderately dilated, equal, and reacted to light. There was slight paralysis of the right side of the face. The only external injury was a lacerated wound over the right parietal region, one inch in length and extending down to the aponeurosis. The reflexes were slightly exaggerated and there was no paralysis of the extremities. The pulse was 70 and slightly irregular. Systolic blood-pressure, 125; respirations, 32 per minute. A lumbar spinal puncture revealed a very bloody spinal fluid under little if any tension. At the end of three hours he had become entirely unconscious and could not be aroused. He had vomited once, projectile in character. During this time the pulse rate and blood-pressure observations showed that the pulse rate had decreased to 50 and the blood-pressure increased to 160 (see Fig. 1). The right pupil was greatly dilated and no longer responded to light.

Operation.—Right subtemporal decompression. Evacuation of blood clots. Drainage of middle fossa. With the aid of very little ether as an anæsthetic, the usual subtemporal decompression was made on the right side. When the dura was exposed it was found to be blue in color and very tense. There was no extradural bleeding. On opening the dura there was immediately an escape of very bloody fluid, containing several small blood clots. The cortex was blue and tense. A small

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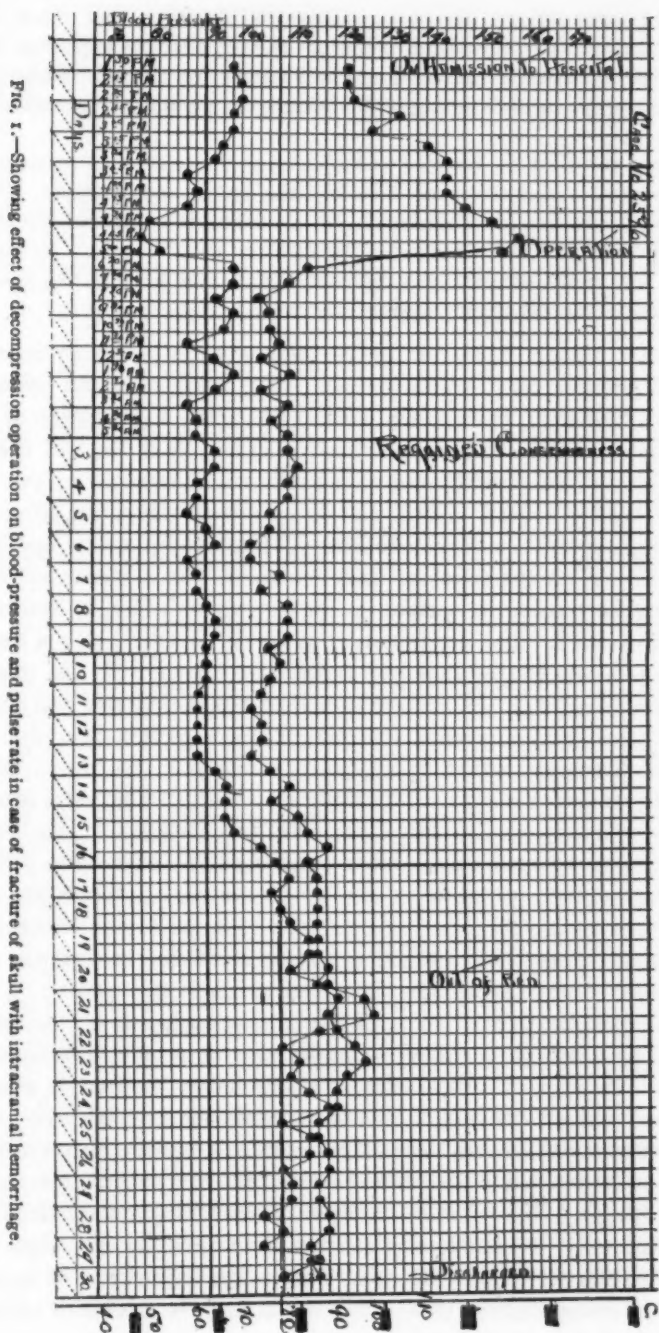


FIG. 1.—Showing effect of decompression operation on blood-pressure and pulse rate in case of fracture of skull with intracranial hemorrhage.

spatula was introduced into the middle fossa towards the base of the brain and more bloody fluid escaped as well as three fair sized blood clots. As there was no active bleeding visible, a small cigarette drain was introduced into the middle fossa and the wound closed. The patient stood the operation well and left the table with a pulse of 90 and blood-pressure 105.

During the first 24 hours after operation he was very restless and although very stuporous was able to take some nourishment. After 48 hours the drain was removed and he occasionally answered questions. On the fourth day he answered all questions intelligently. From this time on his convalescence was uninterrupted and he left the hospital thirty days after his injury apparently well.

It has not always been our good fortune to observe an increase in intracranial pressure as in this instance. Most cases operated upon in this group, when first seen, had already developed such a high degree of tension that its relief was necessary immediately. In this case we had the opportunity to observe the development of a fairly rapid increase of intracranial pressure following a head injury, and to note with the usual clinical signs of cerebral compression a definite increase in the blood-pressure and decrease in pulse rate. With the relief of pressure there was a return of the pulse rate and arterial tension to normal on the seventeenth day, as shown in the accompanying chart. The continuation of the bradycardia for a time after operation as shown in this case has frequently been noted. In some cases there has been almost an immediate return of blood-pressure and pulse rate to normal after decompression, but within seven to ten days the slowing of the pulse rate again makes its appearance and in a few cases a moderate rise in blood-pressure occurs. Although no ill effect has ever been noted from this secondary rise in blood-pressure and slowing of the pulse, on several occasions we have used lumbar puncture in an attempt to relieve any pressure that might be present. A similar phenomenon, though less marked, has been noted during the first week in some cases of severe concussion. It is possible that this secondary reaction may be attributed to a slowly forming post-traumatic cerebral oedema as described by Cannon.¹¹

Twenty-three, or 30.2 per cent., of the 76 cases, when first seen, presented evidence of an advanced medullary compression or severe brain injury (see Table III). In many of these cases the regulatory vasomotor mechanism had collapsed and was no longer able to maintain the arterial pressure above the high intracranial tension. In other cases the rapidly decreasing blood-pressure and increasing pulse rate showed that the vasomotor mechanism was still making a feeble effort to supply sufficient blood to the bulbar centres. We have seen very few cases recover after the regulatory mechanism of the vasomotor system no longer responds. Hence, the importance of recognizing the degree of encroachment upon the medulla and the necessity of relieving pressure before this late stage.

¹¹ American Journal of Physiology, 1901, vol. vi, p. 91.

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We have observed a case (Table III, 624) in which there was advanced medullary compression, and although respirations had ceased just before the dura was opened, breathing was resumed with the relief of pressure and the patient recovered. In another case (Table III, 2425) in which respirations had ceased and the compression had advanced to such a degree that

TABLE III
GROUP III

Hospital Number	Age	Sex	Operation	Pulse rate and blood-pressure		After operation		Result
				P.	B. P.	P.	B. P.	
2205	32	M.	Decompression	52	160	130	90	Death in 2 hours. Gunshot.
2454	10	M.	Decompression tampon lateral sinus	80	96	76	106	Good recovery.
119	31	M.	Decompression	60	0	140	No record	Death, 13 hours after operation.
1923	3	M.	None	120	80	...	...	Death in 1/4 hr.
60	47	M.	None	120	75	...	...	Death in 2 1/4 hrs.
295	4	M.	Decompression	80	0	130	98	Death 29th day —meningitis.
321	69	M.	None	130	120	...	...	Death in 12 hrs.
624	50	M.	Decompression	72	72	75	115	Well, hernia cerebri.
651	?	F.	None	90	100	...	...	Death in 4 hrs.
740	6	M.	Decompression	90	165	No record	...	Death in 12 hrs.
855	7	F.	Removal of fragments	130	(?)	...	...	Death in 2 hrs.
865	50	M.	Decompression	110	140	132	128	Death in 24 hrs.
928	61	M.	None	100	112	...	...	Death in 34 hrs.
1014	50	M.	None	0?	0?	...	...	Death in 15 hrs.
1692	10	M.	Decompression	100	115	90	100	Death in 10 days
1726	25	F.	Decompression	95	95	130	125	Death in 3 days
1782	58	M.	None	0?	0?	...	...	Death in 35 min.
2145	43	M.	Decompression	115	155	100	135	Death in 3 hrs
2425	44	M.	None	120?	0?	...	...	Death in 35 min., artificial respiration.
2730	20	M.	Removal of fragments	90	90	...	...	Well, gunshot.
2944	63	M.	None	95	135	...	...	Death, 2 days.
902	33	M.	None	140	70	...	...	Death, 24 hrs.
M-?	46	M.	None	130	100	...	...	Death, 2 hrs.

its relief was considered useless, with the aid of artificial respirations we were able to palpate a feeble radial pulse for thirty-five minutes.

Of the 23 cases in this group, 20 resulted in death, a total mortality of 87 per cent. In 12 cases an attempt was made to relieve pressure by operation, although they presented signs of advanced compression, evidenced by irregular, shallow respiration and a rapid, low tension pulse. Only three recovered, giving an operative mortality in this group of 75 per cent. All the cases in this group that were not operated upon died.

After the dangerous stage of advanced medullary compression has been reached, or in cases when injury to brain tissue is extensive, there is little, if any, advantage obtained by a decompression operation. We are inclined to believe that many of the cases operated upon in this group, if seen to-day, would not be subjected to the added shock of a decompression.

Summary.—1. A rapid encroachment upon the intracranial space by any foreign body produces anæmia of the brain and medulla and is associated with a physiological response represented by an increase in the general arterial pressure and decrease in pulse rate.

2. The associated intracranial complications are the dangerous factors in fractures of the skull.

3. When the degree of intracranial pressure equals or exceeds the arterial pressure death results.

4. Frequent blood-pressure and pulse-rate observations not only determine the degree of intracranial pressure, but may be utilized as indications for or against the advisability of relieving the pressure.

5. Intracranial pressure should be relieved before the advanced stage of medullary compression and œdema is produced.

6. The subtemporal decompression is the advisable method for relief of intracranial pressure.

7. By frequent blood-pressure and pulse rate observations fractures of the skull may be divided into three groups: (a) Those cases which at no time show any evidence of intracranial pressure. (b) Cases presenting signs of a definite increase of intracranial pressure. (c) Cases presenting signs of advanced medullary compression or in which there is evidence of severe laceration or contusion of the brain.

The writer wishes to express his thanks to Dr. R. T. Miller, from whose services these cases were reported, and for his help and encouragement in the work.

FRACTURES OF THE SPINE WITH CORD AND ROOT SYMPTOMS

SOME INDICATIONS FOR AND CONTRA-INDICATIONS TO EARLY OPERATIVE INTERFERENCE*

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THERE is no question in surgery in which there has been more difference of opinion than the subject of the indications for and contra-indications to operative interference in fresh fractures of the spine with cord symptoms. Just as in the present war the writers on injuries of the spine by bullets and high explosives are divided into two camps,—some advising extreme conservation, others recommending surgical interference in almost all of the patients,—so, in the injuries of the spine which occur in civil life, there are two groups of surgeons, the radicals and the conservatives.

There are certain premises on which all should agree. In the first place, in spite of the cases reported by Harte, Stewart, Coley, and a few others, it seems definitely established that reunion of the divided ends of the spinal cord is impossible, and that, excepting for seeming microscopic efforts at regeneration, no functionally useful regeneration of the non-medullated nerve-fibres in the cord ever occurs.

In the second place, in complete destruction or disorganization of the spinal cord at any level there is an immediate loss of all power and sensation below the level of the lesion with loss of all the reflexes, and with loss of control of the bladder and rectum. After a few hours or days, some of the defensive reflexes may appear, but these should never be confused with true spinal reflexes. In partial lesions of the cord, on the other hand, some motor, sensory and reflex functions are usually preserved.

There are, however, cases of spinal injury, and we see them in fractures of the spine in civil life as well as in the injuries of war, in which at first the symptoms are those of a complete transverse spinal lesion, but in which, after the expiration of days, weeks or months, a considerable or perhaps complete return of power and sensation occurs. These patients suffer either from an injury of part of the cord with concussion, or entirely from spinal concussion, with a resulting nerve block. In the latter condition complete restoration of health is possible.

The crux of the entire matter lies in the question, "Can we distinguish between a physical interruption of all of the cord fibres at any level, and a temporary nerve block due to cedema of the cord or other temporary condition?" Apparently, up to the present time, the clinical differentiation is often impossible, and a large number of surgeons believe, therefore, that exploratory operations are justifiable. These surgeons argue that, if a transverse lesion of the cord exists, the condition is anyway a hopeless one and operative interference will do no harm.

* Read before the New York Surgical Society, October 24, 1917.

In recent transverse lesions of the cord the fatal outcome is very apt to be hastened by an operation. In crushing injuries of the cervical cord, especially with high fluctuating temperatures, an operation is almost regularly followed, within a few hours or days, by the death of the patient, and everyone who has operated upon patients of this type has had the experience that the general condition of the patient was much worse after the operation. On the other hand, the evidence that I have been able to collect, both from a study of the literature of the subject and from my own experience, has convinced me that no harm will result from a policy of watchful waiting. If the signs of a complete lesion persist, then the injury is very probably an irremediable one; if, on the other hand, some of the reflexes return, the operation can then be performed, and with a much better outlook for success.

In order to determine that the symptoms are really those of a transverse lesion, more than a modicum of neurological knowledge is necessary. In such a lesion, not only all the varieties of superficial sensibility (touch, pain, temperature) are lost below the affected level, but the deep sensibilities (deep muscle sense, vibratory sense) and muscle tone are also abolished. I do not think that this is the time or place to dilate upon the finer neurological disturbances which have to be looked for, but there is no doubt that more careful examinations than those ordinarily made are necessary before one is justified in making a diagnosis of a complete transverse cord lesion. I do not believe that blood in the spinal canal can ever exert sufficient pressure to cause the symptoms of a transverse lesion.

Root pains are usually absent in complete lesions, but they may be present and be so severe that a laminectomy has to be performed for their relief.

The standpoint to which I adhere at the present time is the following: In cervical and dorsal injuries, with transverse cord symptoms, an operation should never be performed until distinct and definite signs of returning sensation and reflexes give proof that part of the transverse diameter of the cord is intact.

The surgeon must be guided by the results of a careful physical examination and by stereoscopic X-ray plates. Too much attention cannot be given to the smallest details. In transverse crushes of the cord, all reflexes are abolished, and, especially for the first forty-eight to seventy-two hours, not even a defensive reflex can be obtained by irritation of the sole of the foot. The return of the flexor reflex of the great toe and the change of the flexor into the extensor type is of very great significance as an evidence of the transmission of some nerve impulses through the cord. It is very important also to test the deep muscle and bone sense, and the vibratory sense with a tuning fork. Both of these are absolutely lost in complete transverse cord lesions. The tone of the muscles must also be tested; in complete lesions just as in complete division of a peripheral nerve, muscle tone is entirely abolished.

In crushing injuries of the lumbar vertebræ, on the other hand, in which

the roots of the cauda equina are affected, a laminectomy should always be performed as soon as shock has been overcome and after an X-ray picture has been taken. There is considerable experimental and clinical evidence to show that regeneration of divided caudal nerves can occur, and laminectomy and suture of the divided nerve ends should be performed. The injuries of the roots of the cauda equina are very apt to be followed by most distressing root neuralgias and by permanent vesical incontinence. Therefore the nerve roots should be freed from all pressure by a wide decompressive laminectomy, and the ends of divided roots should be united by suture. For these reasons the injuries of the cauda equina should be subjected to early operative interference, no matter how "complete" the symptoms.

Partial Lesions of the Cord.—In partial lesions of the cord the problem is an entirely different one. If the injury has not been severe enough to interfere with all of the cord functions, then pressure by dislocated or fractured bone may be contributing very much to the symptoms and the relief of this pressure by a wide decompressive laminectomy is certain to be of great benefit.

The part of the cord that has been irreparably damaged cannot, of course, be benefited, but the compression of a partly crushed cord by bone or blood, or by the intramedullary oedema which follows every cord injury, is certain to cause considerable permanent destruction of nerve-fibres.

The decompressive incision of the cord on its dorsal surface near the posterior median fissure, suggested by Allen, may be tried in those patients in whom the cord is found to be cedematous and swollen. In some of these patients an intramedullary collection of blood can be removed by aspiration with a fine needle, and the harmful effects of an intramedullary collection of blood,—a secondary gliosis or a progressive hæmatomyelia,—can be prevented or reduced to a minimum.

If none of the conditions that have just been mentioned exists, and if the spinal tissue is not compressed by dislocated or by fractured bone, the cord may be angulated or the spinal canal may be much narrowed. The removal of these abnormal conditions by a wide decompressive laminectomy, by the removal of a projecting spicula of bone from the posterior surface of the body of a vertebra, etc., will prevent secondary softening.

Strange to say, there is much more conservatism displayed in these patients, in whom, to my mind, surgical intervention should be instituted as early as possible. Not only are the immediate operative results very satisfactory, but the final results are bound to be better. In these patients with an incomplete crush of the cord, the paralysis and sensory loss below the level of the lesion are not complete; there may be slight sensory but marked loss of motor power; the cutaneous and tendon reflexes may be entirely lost for the first twelve to twenty-four hours; control of the bladder and rectum may be lost at first; there may be continued and agonizing root pains. In many of these patients I formerly believed operative interference should also be delayed—at least for a few weeks. I have, however,

seen secondary softening with all the signs of a complete transverse lesion appear within seventy-two hours, and I have, therefore, operated very early in some of my latest patients. The improvement after these early operations was a striking one, and occurred much more rapidly than in any previously observed cases.

Although there is still much to learn concerning the indications for treatment in fresh fractures of the spine, I believe that, in the present state of our knowledge, extreme conservatism is indicated in the patients with the signs and symptoms of a transverse lesion. The patients with evidences of an incomplete cord lesion should be operated upon very quickly after the injury, unless the signs of interference with function are so slight that no justification for surgical therapy exists, the general condition of the patient is so poor that delay is imperative, or unless the coexistence of other severe injuries precludes operative interference.

THE SO-CALLED "MIXED TUMORS" OF THE SALIVARY GLANDS

WITH A POSSIBLE EXPLANATION OF THE MORPHOLOGICAL BEHAVIOR OF THE TUMOR CELLS

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IN recent years a large number of specimens of the so-called "mixed tumors" of the salivary and lachrymal glands have been reported. These are very complicated tumors. It is generally agreed that they take their origin in fetal misplacements. They contain elements whose origin has been assigned either to ectoderm, to mesoderm, or to a combination of both these germ layers. The reason for assigning the origin of some of the cells of these tumors to the ectoderm is the morphological appearance of the so-called parenchyma cells. This paper is based upon the study of seven cases and offers a possible explanation of the relationship of these "parenchyma cells" to the stroma cells, especially the chondroblasts.

So far as the clinical features of this series are concerned, they agree with those already reported by others. No age seems free, but the majority appear in young adults. The youngest patient in this series was eighteen and the oldest seventy-six years of age. Four of the specimens occurred in the parotid and three in the submaxillary gland. In gross appearance, the specimens fall readily into four groups.

1. "A group of very fibrous tumors with no mucoid degeneration or cartilage formation.
2. "A group of very hard, dense tumors with large amounts of cartilage and very little fibrous tissue or parenchyma.
3. "A group of soft, very cellular tumors with trabeculae of transparent mucous tissue running in and surrounding the areas of the parenchyma which are yellowish in color and opaque in appearance (parenchyma)" (Wood¹).
4. Tumors closely resembling carcinomas (Wilson and Willis²).

Cartilage is found in three of our specimens and is usually stated as occurring in twenty-five per cent. of all specimens. Series of mixed tumors of this region, however, have been reported by Speese³ and others in which one-half of the specimens contained cartilage. Osteoid tissue may be found, but true bone is very rare; neither was observed in this series.

Injury does not appear to be an important factor in the development of these tumors. In only one of this series is there a distinct history of injury and this is that of an acute trauma. In this case, occurring in a student, twenty-seven years old, the tumor appeared to follow a kick on the jaw received in a football game.

✓ This series corresponds in general with those reported by others in that metastasis appears rare, while local recurrence is not infrequent. One of our cases had the tumor removed three times and a recurrence was present at the time of death. Even in this case, however, there was no evidence of metastasis.

Microscopically, sections from three of the specimens present in their stroma numerous areas composed of cartilage. In none of the specimens is there found osteoid tissue or bone. All of the primary tumors, except the one specimen falling definitely in the carcinoma group, present a varying amount of mucoid tissue.

In the three tumors belonging to groups 1 and 2, the tumor cells are flattened out and exhibit an attempt to form interlacing or anastomosing tubules lined by a single layer of cells. Apparently due to compression, the flattening has become so pronounced as to make the resemblance of these cells to endothelium quite striking. There is no direct evidence, however, to show that these cells are of endothelial origin. This agrees with the conclusion of Wilson and Willis that "a careful examination of the flattened and distorted cell groups, so frequently interpreted as 'endotheliomas,' leads one to the belief they are either (1) adult epithelium which has been flattened and distorted by pressure, or (2) proliferating embryonic transitional mesothelium which has never attained adult type."

In three specimens the cells of the parenchyma take on a more distinctly epithelial appearance and suggest the normal histological structure of a gland. There is apparently a direct relationship between the amount of parenchyma, the rate of its development, and the degree of malignancy. This is illustrated by one of our specimens, a tumor of the left parotid gland of two and a half years duration, which occurred in a man seventy-six years old. It had in this time attained the size of a small walnut. There is a large amount of mucoid stroma and the parenchyma cells appear flattened, due to compression. The interlacing cordon of parenchyma cells in the stroma gives one the impression of a low grade of malignancy. A recurrence at the end of five months shows an increase in the amount of parenchyma and a decrease in the stroma. Another recurrence removed at the end of the following year shows a tumor composed almost entirely of distinctly epithelial cells.

In one specimen, a tumor of the submaxillary gland, there is such a preponderance of distinctly epithelial cells that it is almost certain that the tumor is a histoid carcinoma of the epidermoid variety. However, the separation from the glandular tissue by an unbroken capsule of connective tissue and the fact that the tumor was primary in the gland are the obstacles encountered in making such a diagnosis. The patient died one year later with an extensive recurrence.

As to the theories of the origin of these tumors, Wood concludes, "The complicated structure of the stroma, containing as it does elements such as embryonic connective tissue, cartilage, bone, fat and lymphoid tissue, and very rarely striated muscle, is explained most easily by the assumption of an embryonic misplacement of mesoblast. The structure of the parenchyma is so slightly characteristic in morphology that its epithelial nature in all cases can only be considered as probable; yet in about 24 per cent. of the tumors examined the presence of epithelium is undoubted. The form and relationship of the cells of the parenchyma do not furnish sufficient data to justify these cells in being regarded as of epithelial origin." Speese³ feels warranted in concluding that the parenchymal cells of these tumors are in

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part, at least, epithelial. Verhoeff,⁴ from a study of five cases of tumor of the lachrymal gland, states his opinion as follows: "The mixed tumors of the lachrymal and salivary glands (so-called endotheliomas) are essentially epiblastic in origin. The stroma of these tumors is derived from mesoblastic cells misplaced from other structures, but is probably produced by an atypical development of cells which ordinarily would have gone to form part of the stroma of the normal gland."

Martini,⁵ in a discussion of six cases which he reported, thinks he can trace the origin of the tubules and cell formation of the parenchyma from proliferated endothelium. Wilson and Willis conclude that, "There is considerable evidence to support the theory that these tumors are mesotheliomas of embryonic origin."

It is apparent from these quotations and the writings of others that the difficulty in assigning an origin to these tumors is in the behavior of the so-called parenchyma cells. At times they appear as of epithelial and again as of endothelial nature. The presence of these cells has been explained by postulating an inclusion or rest of mesoblastic tissue early in the development of the gland or by the inclusion or rest of epiblastic tissue.

The authors are of the opinion that a simpler explanation of these new-growths is at hand, if one takes into consideration that the derivation of some of the head cartilages can be ascribed to epithelium. One of the authors in collaboration with F. L. Landacre⁶ has demonstrated that cartilage in the urodeles can be derived from epithelium. This fact, strange as it seems, is not a mere hypothesis but can be convincingly demonstrated. It is not a new observation, but a confirmation of work which dates back as early as 1878 when Marshall⁷ recognized that some of the epithelial cells of the neural crest in the head region went into the formation of mesenchyme, but could trace them no further. This idea was gradually enlarged upon until, in 1893, Miss Platt⁸ made the statement that the branchial cartilages in neoturus are formed from cells whose origin could be traced back to ectoderm. This fact, in part or in whole, has been confirmed by a number of investigators, including Kupffer,⁹ Lundborg,¹⁰ and Dohrn.¹¹ Like any other scientific fact, it has been rejected by some but largely by those of the older school of embryologists who held to the theory of the integrity of the germ layers. This work has not been confined to any one type or class of the vertebrate series, but includes some of the fishes, amphibians, and even in birds it is known that some of the epithelial cells of the neural crest do not go into the formation of ganglia, but are differentiated into mesenchyme. Confirmation of this subject is still lacking in the mammals and probably will be on account of the absence of certain conditions of cellular morphology such as the existence of a large amount of yolk and presence of pigment granules which is necessary to trace and recognize the mesenchyme formed from ectoderm. We are, nevertheless, of the opinion that there is a possibility if not a probability that there is in the head and branchial region of the human embryo mesenchyme which has been derived from ectoderm. Later this may differ-

entiate into cartilage and possibly into other derivatives generally assigned to mesenchyme derived from endoderm.

Assuming then that this hypothesis is tenable, it gives a ready explanation of the morphological behavior of the tumor cells in these mixed tumors of the salivary glands. If these tumors arise from an inclusion or misplacement of mesenchyme derived from ectoderm, all the tissues found can be accounted for at once. Either the cells fail to differentiate and simulate the cells from which they arose, or they differentiate along the lines they normally do and form connective tissues, cartilage and sometimes bone.

Summary.—From a study of seven specimens of the so-called mixed tumors of the salivary glands, it seems probable that there is in the head and branchial region of the human embryo mesenchyme which has been derived from ectoderm, and that inclusion or misplacement of this ectodermal mesenchyme gives rise to the so-called mixed tumors of the salivary glands.

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HYGROMA COLLI

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HYGROMA colli is relatively rare. The careful collective investigation of international literature made by Dowd¹ in 1913 makes a review of the subject superfluous. To his compilation of 91 cases he has added 3 others. Since then a like case has been reported by Smith² and later another by Cameron.³ It is the purpose of this report to place on record an additional case which recently came to Dr. Kahn's care in the Children's Hospital.

The patient, a healthy looking girl of seven years, was brought because of a disfiguring tumor of the right side of the neck (Fig. 1). There was nothing in her family or personal history that would be considered noteworthy save that when eleven months old she fell from a table. When thirteen months of age the growth, the size of a guinea egg, was first detected by the parents, who, thereafter, closely observed its gradual enlargement. It was never tender and at no time showed inflammatory signs. When the child was two years old the tumor, having attained the size of a chicken egg, was drained by an incision which, quoting the parents, "spurred blood." Prompt healing of the wound was followed by reappearance of a steadily growing tumor.

Local Condition.—When admitted to the hospital there presented over the posterior triangle of the neck a conspicuous ovoidal tumor about the size of a goose egg, the fundal end extending downward to the clavicle. It was painless, soft and fluctuant, incompressible, without impulse and seemingly unilocular. The overlying normal skin was not adherent and bore no visible evidence of previous operation. No enlarged lymph-nodes were palpable. Translucency test and exploratory puncture confirmed the cystic character of the growth.

Operation.—A straight incision over the long axis of the tumor exposed a thin-walled cyst. Its pressure had so thinned the sternomastoid and trapezius muscles that their contiguous borders were poorly defined. No special difficulty was encountered in dissecting the cyst from its bed except at the upper part, where it was intimately adherent to the triangle floor. Under the posterior border of the sternomastoid and closely connected with the cyst was a smaller one, the size of a pecan. It was more deeply embedded in the neck and its amber hue contrasted with the pale blue color of the larger cyst. In its excision the thin wall was nicked, but the drainage of its straw-

¹ Dowd: ANN. SURG., 1913, lviii, 113.

² Smith: Jour. Am. Med. Assn., 1914, lxii, 522.

³ Cameron: Canad. Med. Assn. Jour., 1916, vi, 137.

colored, serous contents caused no perceptible reduction in the size or tension of the adjoined cyst, giving the inference that their cavities did not communicate. The growth was completely extirpated, the larger cyst being removed intact. There was no obvious attachment to any vessel and hæmostatic ligatures were unnecessary. With a continuous horse-hair suture the skin wound was closed. A small rubber band for drainage was left in its lower end. Subsequent healing was without incident.

Pathological Report (Dr. Graves).—Gross description: Specimen consists of thin-walled cyst, measuring 3 x 6 x 8 cm. as it lies on board. It is covered with tags of fibrous tissue between which wall is pale blue. By transmitted light contents are translucent and pale pinkish red. Cyst fluctuates and appears to be unilocular. At one side is an area about 2 cm. in diameter which is smooth, pink and glistening and around which are remains of wall of cyst, the smooth area apparently being a part of wall of same emptied cyst. Surgeon states this was opened at operation and thin, straw-colored fluid escaped. After fixation for museum, cyst is opened and found to be unilocular, with a smooth, pale lining.

Gross Diagnosis.—Multilocular hygroma.

Microscopical description: Sections of small punctured cyst show thin wall of fibrous tissue. Outer surface bears fat and some fragments of muscle. Inner lining has been rubbed off, making it probable that it was endothelial rather than epithelial. Sections of larger cyst show an endothelial lining.

Microscopic Diagnosis.—Multiple hygroma colli.

Comments.—These multilocular, serous, cervical cysts in children are probably due to distention of embryonic sequestrations of lymphatic tissue. They are usually lined with endothelium. They have the power of persistent, irregular growth. Trauma, in some cases at least, seems to be a decided factor in stimulating this growth. Their inherent power of development is sufficient to force themselves into surrounding structures. In multilocular hygroma the serum in one compartment may be clear, while in an adjacent one it may be tinged with hæmoglobin. After birth the growth may show a capricious enlargement with no tendency toward spontaneous recovery. The aggregation of cysts, although presenting superficially, originates beneath the deep cervical fascia and most often appears in the posterior triangle of the neck. In the submaxillary region its clinical differentiation from branchial cyst is not always easy.

After partial removal the tumor has, according to Murphy, returned with enormous increase in size and secretion. This assertion, together with Bloodgood's observation of late malignant development, indicates that the proper treatment of cystic hygromata is early, clean and complete removal.



FIG. 1.—Child showing hygroma of neck.



FIG. 2.—Exterior of larger cyst with inner surface of base of smaller cyst facing.



FIG. 3.—Interior of opened larger cyst.

PULMONARY TERATOMA

REPORT OF A CASE WITH REMARKS ON OVIGENOUS TUMORS *

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THIS is a report of a case of pulmonary teratoma operated by ourselves at the Spartanburg Hospital, followed by a discussion of the present state of knowledge concerning teratomas and dermoids in general, their origin, pathology, symptomatology, diagnosis, prognosis and treatment.

In the lung teratomas are very rare, and until recently little was known concerning them. Unfortunately, at present little can be done that is permanently remedial, but further study and wider experience may soon enlighten the subject.

An adult white male, aged forty-six, native of North Carolina and planter by occupation, presented himself on June 12, 1915, at the Spartanburg Hospital, for diagnosis and treatment.

His family history was negative as was his personal history, save for an attack of measles during childhood and a typhoid infection at twelve. He had always lived a fairly regular life and, although he smoked and drank occasionally, he positively denied the venereal infections.

His chief complaints were persistent soreness through the left chest, occasional cough and some dyspnoea. These he attributed to a blow from a falling tree, received ten months previously.

The chest showed slight respiratory diminution over the left side anteriorly, yet the chest was apparently symmetrical in contour. There was no venous distention nor œdema of the neck. Palpation revealed diminished vocal resonance over the left chest front and back, more marked over the latter.

Anteriorly the left lung was fairly resonant throughout, but posteriorly from the fifth to the eighth interspace there was a decided degree of dulness and over this area the breath sounds were absent. The right lung was clear and rather hyper-resonant throughout.

There was no visible or palpable cardiac impulse. The apex thrust was not visible, yet its sound was heard best in the fifth left interspace two inches inside the nipple line. There was no thrill nor shock. The heart sounds, though regular, were but faintly audible. There was no murmur, but the pulmonic second sound was slightly accentuated. The pulse was regular, of fair volume, eighteen to the quarter, and not sclerosed. Physical examination otherwise was negative.

* Read before the South Carolina Medical Association, April, 1916.

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The supposition was that there was an area of consolidation of fluid in the left lung situated more nearly the posterior than the anterior chest wall.

On the following day an aspirating needle was inserted through the sixth left interspace just behind the posterior axillary line and 30 c.c. of blood-tinged yellowish serum were obtained. Smears and cultures made from this fluid showed no microorganisms, but a few endothelial cells.

The patient's chest was skiagraphed and a large, round shadow in the left lung showed on the plate.

June 26 the patient was sent to the Jefferson Medical College Hospital, where again he was tapped, skiagraphed, fluoroscoped and studied clinically by Professors J. C. DaCosta and H. A. Hare. The diagnosis remained uncertain, but operation was advised. He refused and returned to his home. He came to us again and was given five X-ray treatments, after each of which he complained of great pain and was troubled with increased cough. Another skiagraph showed that the diameter of the shadow had increased one-half inch. He left the hospital, but returned on July 28, requesting that the operation be performed, because of an increase in the soreness, in the frequency of the cough and because of an impairment in his speech.

On the following day he was etherized and three sides of a quadrangular flap were dissected upward and turned backward over the vertebral column from above the sixth to just below the eighth rib. The subjacent muscle fibres were divided and two inches of the sixth and seventh ribs were removed. The pleura immediately bulged and pulsated. It was greatly thickened and evidently adhered to the lung. As a precautionary measure it was stitched to the lung by two chromic catgut sutures one and one-half inches apart. The cautery was carried inward between these two points and a considerable amount of yellowish serum exuded through the opening thus formed.

The finger was inserted, the tip of which barely reached the anterior wall of the cavity, where the beat of the heart could be easily felt. A number of pieces of whitish cheesy material were removed. The cavity was partially dried and drained by rubber tubing and iodoform gauze carried through a fenestrum in the flap which was sutured back in place. The wound was cleansed and dressed and the patient was returned to his room in good condition. He reacted well from the ether and the operation and, though the wound continued to drain freely, he was in due time up and about the hospital. The wound was irrigated frequently with varying percentages of stimulating solutions. Drainage continued.

He gained some weight and felt much better. On August 28 he left the hospital, but remained under the care of his family physician who dressed the wound daily. The drainage almost ceased, only to reappear a few weeks later, increased in amount and rather foul in odor. He ran a noonday temperature of a degree or a degree and a half and had chilly sensations at frequent intervals. His strength gradually waned; both eating and talking intensified the cough and he complained a great deal of pain in the left chest which frequently radiated down the corresponding arm and occasionally extended to the left hip.

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During the third week of November he had a hard spell of coughing, spat up considerable blood and more still appeared on the dressings. Another week passed, and he had another hemorrhage from which he rallied slowly, having been rendered unconscious for nearly three hours.

On December 8 he was again fairly cheerful, ate his usual supper, and retired for the evening. He was asleep but an hour when he developed a severe paroxysm of cough and died a moment later in a deluge of blood.

Sections of the tissues removed at operation were stained and studied by Dr. W. M. L. Coplin, Professor of Pathology at the Jefferson Medical College, who made the diagnosis of pulmonary teratoma. Autopsy was not obtained, but more tissue was secured from the lung at the time of death and Dr. Coplin again reported pulmonary teratoma, sections of which also revealed the presence of a few carcinomatous cells.

Remarks.—Teratomas are commonly solid neoplasms, although not infrequently cystic and contain epithelial and connective-tissue elements. Dermoids practically always are cystic and with one exception are congenital in origin. They spring either from embryonic cutaneous inclusion or from the growth of a misplaced and blighted ovum. When not congenital they develop from nests of epithelial cells that were carried into the deeper tissues during the inception of a punctured wound. Both these tumors may be classified, therefore, as being congenital or acquired in point of origin and as being external or internal in point of location. A few examples of external teratomas are the well-known historical Siamese twins, polydactylism, spina bifida or monogerminal teratomata and the so-called foetus in fetu or bigerminal teratomata.

A single ovum maturing in the normal manner, but for the presence of an excessive face, head, extremity, trunk or pelvis, though rare, is, nevertheless, occasionally seen and is explained by the theory of dichotomization; which in substance is, that in animals there is a tendency for parts ending in free extremities to bifurcate. If the digits are affected, supernumerary fingers or toes are formed, whereas if the dichotomization process extends to the axis of a limb or to the axis of the trunk, two limbs or two trunks more or less perfectly formed are the inevitable result.

The internal teratomas are far more frequent and are the types usually in mind when the term is used.

Dermoids are distinctly more common than both types of teratomas combined.

These morbid processes are usually unilateral, often slow in growth, commonly small in size and, as a rule, are without characteristic symptoms or pathognomic signs. If there be an orifice through which from time to time there emerges a hair, a particle of bone, a piece of cartilage or a varying amount of glandular secretion, the nature of the underlying condition is at once suggested. Physically they are usually firm, occasionally soft, frequently dough-like and sometimes tense and bulging.

Dermoids are made up largely of dermal tissue, plus one or more of its appendages, whereas teratomas are tumors of a peculiar mixed histologic composition (Hilton) and are described by some as containing tissues, organs or systems of organs derived from two or all of the germ layers.

Christian in 1907 spoke of dermoids as structures of slight complexity and of teratomas as structures of great complexity, implying thereby that the latter are composed of a greater number of germinal layers than are the former. The ovary occupies the first, the testicle the second, the sacrococcygeal region the third and the mediastinum the fourth position in point of frequency for the growth of these tumors.

In fact, so rare are they in this last-named space that Hare, in 1888, when reporting a collection of 520 cases of mediastinal tumors or accumulations, only found eight dermoids and one unquestionable teratoma. Since then others have been reported and Christian, in 1907, analyzed seventy cases, of which seven were teratomas and the remainder dermoids.

Among the rarer and more superficial sites for these morbid processes are the outer borders of the temporal canthi, the line of the thyroglossal duct, the region of the facial and the branchial clefts as well as the site of any previously received punctured wound.

In the words of Moschcowitz, "cystic swellings at the outer angle of the eye are usually dermoids," and one should further remember that they frequently are connected to the cerebral envelopes through a small opening in the underlying cranial bone.

Histologically they are composed of two or more of all the known tissues. Unstripped muscle fibres, fat, bone, cartilage, dentin or epithelial cells of a type peculiar to the skin or mucous membrane from which they were originally sequestered, are frequently found in these masses. Christian discovered neuroglia in three of the specimens he studied. In the ovarian and post-anal teratomas unquestionable mucous membranes have been demonstrated and areas of thyroid and mammary gland tissues have been described in teratomas situated far distant from these organs.

But little has been written concerning the so-called *teratoma strumosum thyroideale ovarii*, or teratomas of the ovary with perfectly normal histologic thyroid tissue scattered here and there diffusely through the meshes of the ovarian gland. According to Norris, there are but thirteen positive cases on record. Some histologists have called it a metastatic thyroid carcinoma even in the absence of any recognizable malignant change in the thyroid gland itself. Others have termed it endothelioma, but the microscope does not substantiate this term, and though it may be a colloidal degeneration of an adenomatous ovarian area, it more nearly corresponds to the accepted definition of a teratoma and as such should be so designated.

Clinically, Norris observes that they are of rapid growth, inducive of adhesions and ascites, provocative of painful and irregular menstrual flows, incident to both primiparas and multiparas, and that no case of bilateral involvement has been reported. The thyroid gland may or may not be

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enlarged. They are prone to become malignant, if not already so, but the probability of a surgical cure is better than if it were an unquestionable carcinomatous infiltration.

In the ovaries these ovigenous tumors have much the same morphology as when situated elsewhere. Much has been written of them. The surgical essence of ovarian cysts and tumors in general is extirpation. When one recalls that twenty per cent. of all ovarian cysts are malignant and that twenty per cent. more are potentially so, it behooves the attendant to advise removal of all enlarged ovaries due to new tissue formation of whatever origin.

In the testes and the inguinal canals these morbid entities necessitate differentiation from hydroceles, abscesses, hæmatomas, hernias, undescended testicles, hæmatoceles, benign and malignant tumors and granulomas of a luetic, tuberculous or actinomycotic origin. They should be removed. The perirectal and sacrococcygeal regions, from their embryologic origin and subsequent evolution, attendant as they are with so many developmental defects and "narrow escapes from the same," are peculiarly susceptible to their formation.

In these regions they are round, smooth, encapsulated, sessile or pedunculated. The symptoms produced vary with their anatomic relations and the size of the growth. Within or immediately around the rectum they cause a sensation of pelvic fulness and painful or difficult defecation. An occasional hair may be passed. Blood and pus, or glandular secretions in the fæces, are absent unless there is some ulcerative or destructive process taking place.

Dermoidal sinuses are not infrequent over the sacral bone. They show as small orifices which heal and break down again and again over a long period of time. They are always in the median line. One or more hairs not infrequently emerge from the orifice. Such sinuses demand a wide circular incision down to and even beyond their base. Remove the entire channel. Cauterize or carbolize any outlying cells. Pack the cavity thus formed with plain or iodoform gauze. Do not sew it up.

Teratomas and dermoids situated in front of the sacrum are frequently attached to it by a pedicle. They vary in size from a pea to a man's head. They may remain at their site of development or they may extend forward and show in the perineum. Occasionally they push upwards into the abdomen and even more rarely they dissect downwards and hang between the legs.

The cutaneous coverings of these tumors here, as elsewhere, may be thin, thick, discolored or inflamed. The entire structure is peculiarly susceptible to infection which frequently leads to rapid suppuration. The parturient mother may, through her own efforts at expulsion of her babe, tear the sac or infect its contents.

Sir J. Bland Sutton observes that these tumors in the mediastinum originate from cutaneous and subcutaneous inclusion of cells, with their subsequent dislocation backward, during the process of folding together of the two halves of the body during early intra-uterine life.

Though these cells may manifest themselves later in life as a tumefaction within the sternal bone or beneath its periosteum, they far more frequently are carried further inwards to settle in the anterior mediastinum. Here they involve its contents in the meshes of their structure, and striking anew for further fields of conquest, hurl themselves on to the pericardium or on to the pleuræ and having penetrated one or the other or both of these coverings, attack their enclosed viscera. Strangely enough the heart itself seems to be peculiarly free from invasion.

Pulmonary teratomas originate therefore, *not in the lung itself*, but in the mediastinum, to which place they were primarily conveyed from some portion of the thoracic wall.

Once in the lung itself, they frequently communicate with a bronchus, and coming in contact with the germ-laden air are prone to suppurate. More rarely still they cause anxiety by the presence of a hair or some other epithelial appendage in the expectorated material.

Symptomatically there is nothing specific. One or more of all the classical intrathoracic symptoms may be present, depending upon the size and location of the mass.

Pain, cough, dyspnœa, cyanosis, hemoptysis and articulatory disturbances may be present. Frequently a sense of fulness is complained of. Shaw believes that they differ from pulmonary neoplasms by the absence of cervical œdema and venous distention. On physical examination may be found one or more of all the signs of a pulmonary mass usually revealed by inspection, palpation, percussion and auscultation.

Neither the X-ray nor the fluoroscope identify, in the absence of teeth or bone, the nature of the process.

Clinically, one must eliminate the ordinary benign and malignant neoplasms, gummata, sacculated or button-hole aneurisms, pulmonary abscesses, encysted empyemas, hydatid or echinococcic cysts, tuberculous and actinomycotic granulomas before the diagnosis of pulmonary teratomas or dermoids can be made.

The diagnosis having been or not having been definitely settled, the question of treatment next presents itself. The method of procedure will vary with the age and comfort of the patient, the size and location of the mass and with the experience and judgment of the surgeon. In the presence of signs and symptoms that warrant surgical interference the prime object is, of course, to remove the mass *in toto*. This has been successfully performed in but one case. If the mass is so inaccessible as to prevent such accomplishment and yet is sufficiently large to impede circulation or to impair respiration, the chest is to be trephined and the cyst incised that it may freely drain. The cavity then should be irrigated as indicated with a stimulating solution of iodine, copper sulphate, lysol or a two per cent. solution of aluminium acetate. Even then usually the best that results is the formation of a fistula which persists as a rule until death occurs from some intercurrent disease or complicating condition.

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This explains why such growths should always be let alone until they are seriously interfering with the physiologic functions of the intrathoracic viscera.

Drugs, of course, are of no avail save the opiates, which modify the pain. It is doubtful if any such case has been cured by the X-ray or by the application of radium. This leaves the surgeon, therefore, with the knife and cautery as his weapons of choice for allaying or prolonging the inevitable end which occurs in practically all cases of pulmonary teratoma and dermoids whether they be operated or non-operated.

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GASTRODUODENOSTOMY: ITS INDICATIONS AND TECHNIC

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GASTRIC surgery has attained its present high place as a result not only of the impetus received from the early contributions of American and English surgeons but also from an increasing coöperation between clinician, röntgenologist and surgeon, the investigation of the causes of past failures, a clearer conception of the indications for operation, the more careful observance of general surgical principles, and, particularly, a more intelligent appreciation of the specific merits of the many technical procedures, old and new, which are at the disposal of the surgeon in the treatment of benign gastric and duodenal lesions. Further progress can well be expected as the experience of those who are particularly interested in the subject of gastric surgery becomes available, and it is with this in mind that I draw attention to the operation of gastroduodenostomy.

Gastroduodenostomy is not an infrequent operation, inasmuch as the various types of pyloroplasties (Finney, Heinicke, Mikulicz, etc.) are essentially anastomoses between stomach and duodenum. The operation to which I have reference does not include in its technic any interference with the pylorus, nor does it utilize the ulcer callus as any part of the posterior wall of the anastomosis. In other words, the ulcer area is purposely avoided and the anastomosis is made entirely in healthy tissue.

Historically, the operation of gastroduodenostomy is of some interest.

Moynihan credits Jaboulay as the first to suggest and carry out gastroduodenostomy (1892 and 1894). Many modifications of this principle have been proposed. Kümmell divided the duodenum, closed the proximal end, and implanted the distal into the anterior wall of the stomach near the greater curvature. Billroth, Villard, Terrier, and Kocher devised other methods of accomplishing the operation. Kocher advised an elaborate mobilization of the duodenum (the descending and a considerable portion of the transverse portion) by dividing the parietal peritoneum covering the kidney. The operation he named "lateral gastroduodenostomy." In this country by far the most popular form of this principle has been the pyloroplasty of Finney, an operation which has the advantage of permitting, under certain conditions, the safe excision of the ulcer, as well as making possible the inspection of the mucosa in the immediate vicinity of the pylorus.

It is important to become familiar with these various methods and to know their indications, for only with such knowledge will the error of forcing a favored operation to apply to unsuitable conditions be avoided.

The circumstances we have recognized as justifying a gastroduodenostomy of the type described in this paper are as follows:

1. A pyloric lesion or a lesion involving the pylorus, associated with marked obstruction, with more or less ballooning of the duodenum pro-



FIG. 1.—High lying duodenal ulcer causing an angulation which brings the upper duodenum and the pyloric end of the stomach in close apposition. Gastroduodenostomy made below ulcer and ulcer covered. See Fig. 2.

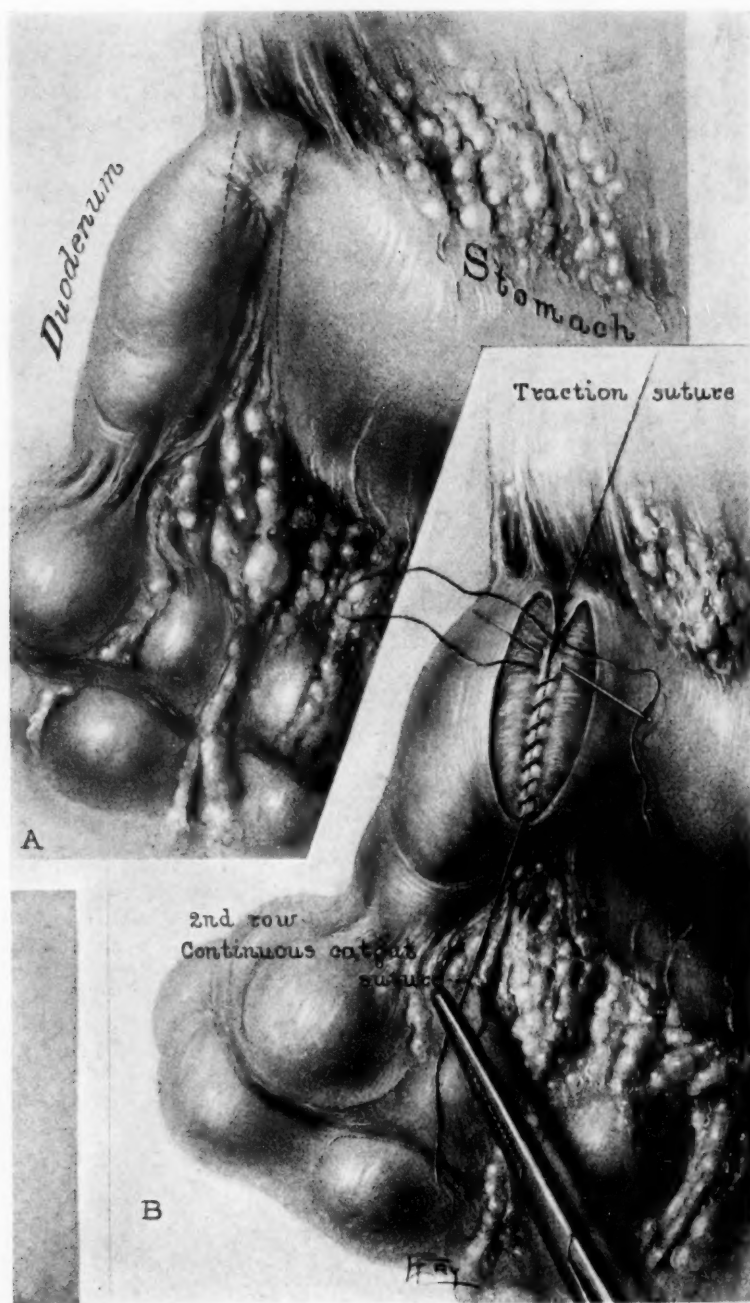


FIG. 3.—A, easily mobilized duodenopyloric ulcer. Gastroduodenostomy made in front of the ulcer.
B, gastroduodenostomy in progress.

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ducing a deformity the counterpart of an hour-glass stomach (Figs. 1 and 2). Particularly if such a lesion is active or has caused the pylorus to become fixed to pancreas or liver, or in a mass of adhesions, should the advisability of gastroduodenostomy be taken into consideration. At the same time we would still give posterior gastrojejunostomy the preference in this group, with gastroduodenostomy as an excellent alternative, reserving the latter as the operation of choice in the groups to follow.

2. Any condition such as those indicated in Group 1, complicated by anatomical derangements (either congenital or the result of previous inflamma-

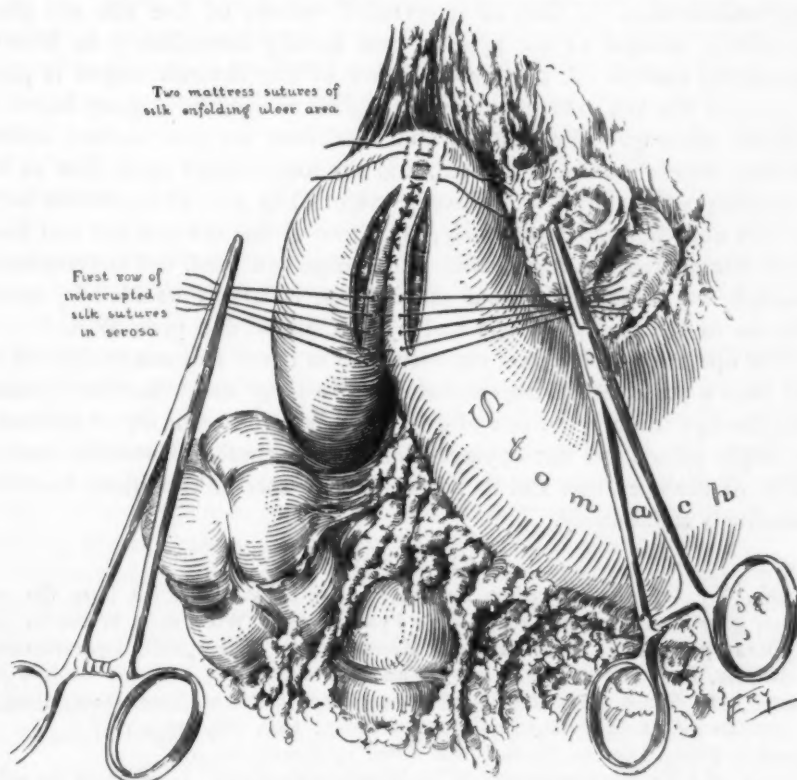


FIG. 2.—Gastroduodenostomy for obstructing ulcer with an angulation. See Fig. 1.

tory exudate) of a nature to preclude or make inadvisable a posterior gastrojejunostomy.

3. In those instances in which patients have failed to obtain the expected relief from gastrojejunostomy because of secondary complications, such as gastrojejunal ulcer and mechanical difficulties, because the operation was ill-advised or improperly done, or because of unknown reasons, gastroduodenostomy has been of signal value following the cutting-off of the gastrojejunostomy and the restoration of the walls of the stomach and jejunum.

It should be mentioned that the lesion in these various conditions, as far as can be determined, is a chronic ulcer, that it is not safely excisable and that

conditions are such that a pylorotomy is not justified because of the operative risk.

The operation we have carried out is as follows:

The best possible exposure and mobilization of the pyloric end of the stomach and duodenum is obtained. In many cases this exposure is already strikingly in evidence, while in others much aid may be gained from the careful division of the adhesions which course over the prospective field of operation. Markers are now placed close to the inferior border of the duodenum and stomach at such points as to insure, when approximated, a sufficiently large anastomosis. A line of interrupted sutures of fine silk are placed posteriorly, parallel to the pylorus, and usually immediately in front of the scarred tissues. A continuous suture of fine chromic catgut is placed in front of the silk suture, extending slightly above and slightly below the proposed opening. The stomach and duodenum are now opened, actively bleeding vessels separately ligated, and the anastomosis made just as in a gastrojejunostomy with No. 2 chromic catgut (Fig. 3). The posterior suture lines are now duplicated anteriorly, *i.e.*, a row of fine chromic gut and finally a few interrupted sutures of silk. No clamps are used, but contamination, although not possessing serious possibilities, is largely avoided by careful isolation of the operative field and by suitable wound protection.

The operation under good circumstances is easier and can be done in less time than a posterior gastrojejunostomy. In other cases, however (usually when the operation is not one of choice), exposure is difficult on account of the deeply placed and fixed pylorus, but even in these unfavorable cases the results of the operation and its adaptability to specific conditions have been exceedingly satisfactory.

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TECHNIC OF OPERATION FOR REPAIR OF THE ILEOCÆCAL VALVE

WITH SUMMARY OF THE RESULTS IN A SERIES OF TWENTY-SIX CASES

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IN the November issue of *Obstetrics, Gynecology and Surgery*, 1913, I presented a paper describing a method for repairing the incompetent ileo-cæcal valve and also a method for making an artificial valve. The purpose of this paper is to present additional points relating to the technic of the operation for repair of the ileocæcal valve and to present a brief summary of the results in a series of twenty-six cases in which the valve was repaired in connection with some other operation requiring abdominal incision.

The operation for repair of the valve is exceedingly simple in principle but requires delicate manipulation and an exact and careful technic in execution. It is obvious that obstruction may be produced by a faulty technic and the patient's life may be imperiled.

The thoroughgoing X-ray examination which reveals the incompetency of the ileocolic valve will also almost certainly disclose other lesions, such as prolapse and adhesion or incarceration of the pelvic colon, a common cause of incompetency. As clear an idea as possible of the conditions present must be gained by other modes of examination and by a careful clinical study of the case so that the incision may be made at a point from which the several lesions present may be dealt with if advisable.

If obstructive adhesions of the pelvic colon exist, the incision will be made in the median line so that both lesions may be dealt with from the same opening. If there is reason to believe that the gall-bladder is affected, or that lesions exist at the hepatic or splenic flexures, the incision should be made at about half an inch to the right of the median line and will be four or five inches in length, the junction of the upper and middle thirds of the incision falling opposite the umbilicus. An incision at this point makes it possible to deal with the ileocæcal valve or the appendix and to inspect the stomach, the gall-bladder and the hepatic flexure of the colon.

The principle of the operation is simply the restoration of the valve by invagination into the colon and constriction of the lumen of the widely stretched ileocolic junction to its normal size. Both things must be done; neither one alone will repair the valve.

In the normal subject the ileocecal valve consists of two folds so placed that the slit-like opening between the folds lies transversely in relation to the horizontal axis of the large gut. The object sought is to restore these folds by invagination of the ileum. The operation may involve the restoration of either the upper or the lower segments of the valve or both.

With the cæcum and a few inches of the ileum drawn out through the incision and properly disposed, it is generally easy to see on the anterior face of the gut close to the upper side of the non-vascular fold of Treves (ileocæcal fold) the line where the ileum joins the colon. From this point the junction may be easily traced for two or three centimeters along the upper border of the ileocolic opening, but beyond this point it is usually covered and obscured by a plexus of tortuous veins which are sometimes buried in fat.

The lower half of the junction, beginning at the non-vascular fold of Treves, generally comes fully into view as soon as the fold is lifted and turned upward. Not infrequently, however, the fold of Treves is fixed by adhesions to the cæcum, the ileum or the appendix in such a way as to completely conceal the lower half of the junction. Sometimes also the appendix or its mesentery is adherent in such a way as to conceal the line of junction. It may be concealed by bands formed between the cæcum, the appendix and the ileum, or by a fold of the ileum itself when bound by adhesions to the brim of the pelvis—Lane's kink. Before the repair of the valve can be undertaken, the junction must be brought clearly into view by the separation of adhesions. I think it important to note, however, that not infrequently these adhesions seem so clearly to be of a reparative character that it appears best to let them alone. Non-obstructive adhesions should be left undisturbed.

When the valve is competent, the line of junction between the ileum and the cecum cannot be seen, for the reason that it is located at the inner free border of the valve lips and so lies within the colon. It is only when the invaginated end of the ileum is pulled out, destroying the valve, that the anatomical junction of the ileum and the colon comes into view. When the junction line is visible, this fact alone proves incompetency.

A most striking anatomical feature of the incompetent valve is the form of the gut at its terminus, which is so characteristic that the lesion may be instantly recognized when the cæcum and terminal ileum are exposed to view (Fig. 3). Normally the small gut is narrowed at its junction with the cæcum. When the valve is incompetent, the wide stretching of the junction gives the terminus of the ileum a funnel shape (compare Figs. 1, 2 and 3). This is the natural result of the pulling out of the invaginated end of the gut and the overstretching of the cæcum to which the incompetency is due. The lumen of the normal ileocæcal junction measures two to two and one-half centimetres; when incompetent, four to seven centimetres.

After the gut has been brought into view and examined, the valve may be tested, compressing the gas-distended cæcum in such a way as to force the gas back into the small gut unless checked by the ileocæcal valve. It may be necessary to compress the ascending colon so as to confine the gas in the cæcum while making the test.

In testing the competency of the valve, it is sometimes at first found

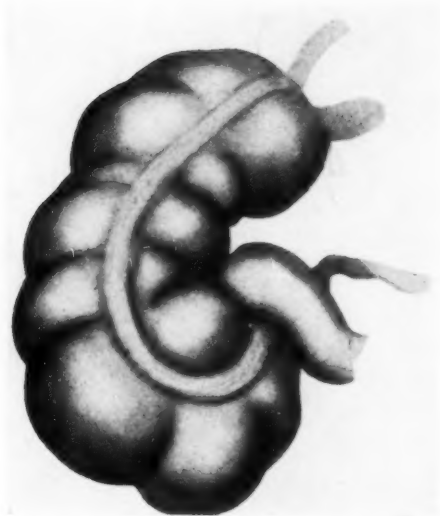


FIG. 1.—Normal caecum and terminal ileum.

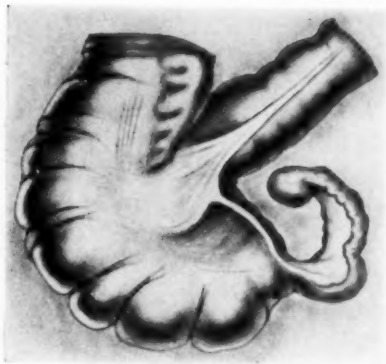


FIG. 2.—Caecum and terminal ileum of the chimpanzee.

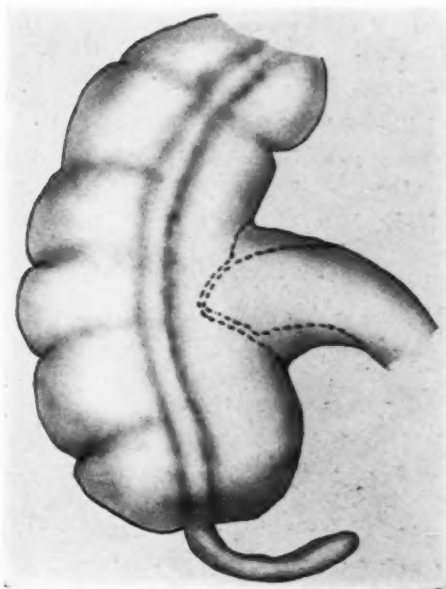


FIG. 3.—Incompetent ileocaecal valve. The dotted lines show the form of the normal junction and valve.

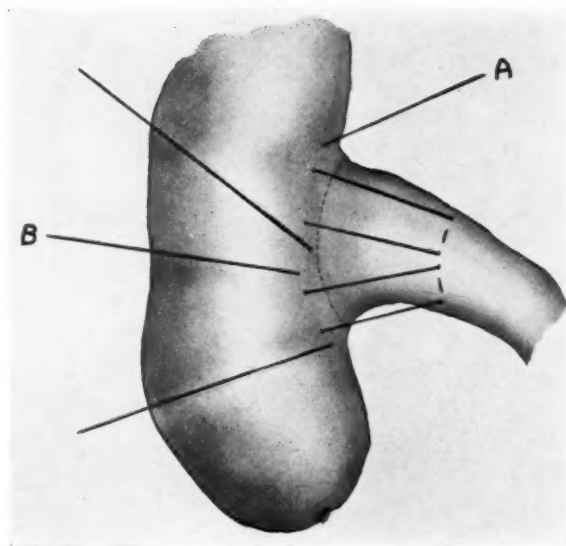


FIG. 4.—*A*, first anterior suture; *B*, second anterior suture.

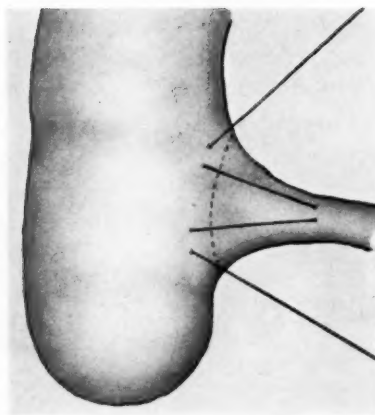


FIG. 5.—V-shaped suture.

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impossible to cause reflux of gas into the ileum by pressure upon the cecum in cases in which the appearance of the ileocolic junction clearly indicates a marked degree of incompetency. In such cases, a slight change in the position of the ileum in relation to the colon will at once reveal the incompetency of the valve by permitting the gas to pass freely from the colon into the ileum. This temporary competency of the valve may be due to an accidental disposition of the folds of mucous membrane about the ileocolic junction in such a way as to mask the incompetency. If the ileum is placed at right angles to the colon, or if gas is pressed into the colon from the ileum, the true condition of the valve is at once disclosed by the sudden refilling of the terminal ileum with gas, often with a slight puffing sound when pressure is made upon the cæcum.

In nearly every case of incompetency of the valve the upper or superior valve is found to be deficient, while the lower valve is not infrequently found to be intact as shown by the fact that the ileum is not disinvaginated at this point. For this reason I usually begin the operation by restoring the upper valve.

The operation consists in the application of one or more mattress sutures in such a way as to turn in three to three and a half centimetres of the ileum and at the same time reduce the lumen of the opening.

In passing the first suture, the needle should be inserted into the wall of the colon at a point half a centimeter from the line of junction and opposite the mesenteric border of the ileum (Fig. 4-A). This point cannot be seen without first lifting and pushing aside the peritoneum with its veins and fat which cover this part of the junction. To avoid troublesome bleeding and the application of ligatures the dissection must be made with the very greatest care. The loose peritoneum close to the junction is picked up with dissecting forceps, thus separating it from the underlying muscular coat. With a pair of small forceps, the pouch of loose peritoneum thus formed is penetrated and an opening made by separating the blades of the forceps. When this is carefully done there is no bleeding, and by pushing the veins and fat aside the surface of the colon may be readily distinguished by its lighter color. The forceps are pushed under the veins and made to seize the colon at a point at which it is desired to insert the needle in placing the first suture. Of course special care must be taken in inserting the needle to avoid perforating either the veins or the gut. A small curved needle, as a Lane's cleft-palate needle, is best for the purpose. No. 0 silk or celluloid linen is used for the suture.

Before the several sutures are placed, the peritoneal surfaces which will lie together when the sutures are tied are abraded by means of scraping with a sharp scalpel so as to insure prompt and permanent adhesion of the invaginated folds.

The needle is next inserted at a point in the ileum close to its mesenteric border and about three centimetres from the junction. The next insertion of the needle is at a point about one centimetre and a half from the

mesenteric border and three centimetres from the junction line. The needle finally picks up the colon at a point in line with the first insertion and two to two and a half centimetres anterior to it, thus forming what might be called a double mattress suture. The suture is left untied, the ends being grasped by forceps.

Generally a second mattress suture, essentially like the first, is applied anterior to it (Fig. 4-B) and in many cases a third is required on the under side.

Sometimes it is best to give the suture the form of an inverted V (Λ), the base of the V resting upon the colon (Fig. 5).

All the sutures are introduced before any are tied. In tying, a pair of forceps is passed under the suture and held by the assistant in such a way as to make sure that the gut is well invaginated. The knot is left half tied until the valve has been tested.

It is well, after introducing the first suture and thus reproducing the superior valve lip, to test the competency of the valve by first filling the cæcum with gas from the small intestine, then making pressure upon the cæcum in such a way as to force the gas back against the valve and through it in case it is incompetent. If the valve is competent it will bear a considerable amount of pressure without permitting gas to pass into the ileum. If moderate pressure causes a reflux of gas into the intestine with a puff or a low-pitched sound, the repair is not sufficient and further repair is required.

The inferior lip of the valve is now restored by means of a mattress suture applied as described for the anterior, after which the valve is again tested. If the valve is still incompetent, it is necessary to apply a single or a V-shaped invaginating suture at the anterior border of the junction just anterior to the fold of Treves.

After placing the sutures and half tying them, and having proved that the valve is competent, it is highly necessary to make sure that the operation has not been overdone. For this purpose it is only necessary to pass gas from the ileum into the colon by holding and compressing it with a moist napkin at a point eight or ten inches from the cæcum, then passing the gas into the colon by grasping the gut between two fingers and stripping it toward the valve. If resistance is felt, one or more of the sutures must be loosened a little, or possibly removed and the test repeated.

If after repairing the valve moderate pressure upon the distended colon causes a reflux of gas into the ileum accompanied by a high-pitched sound, the inference to be drawn is that the terminal ileum has not been invaginated sufficiently, and also that the sutures produce too much constriction. One or more sutures must be cut and removed and the error corrected.

That the danger of overdoing the operation on the ileocaecal valve may be avoided by a painstaking technic is shown by the fact that a serious obstruction of the intestine due to the operation on the valve has, in the writer's experience, occurred in only a single instance. In not a single case has death resulted from obstruction of the valve.

REPAIR OF THE ILEOCÆCAL VALVE

Care should be taken to avoid much manipulation of the intestines and all exposed parts should be kept well moistened with normal saline solution.

After the operation the patient is cared for by the method of post-operative care which the writer has followed in laparotomy cases for many years. As soon as the patient is transferred to his bed a hot pack is applied to the feet and legs, to lessen pain, a cool friction bath is given and a cold compress is applied to the chest to combat shock. The patient's body is inclined to the left side to lessen strain on the cardiac end of the stomach and thus lessen nausea as suggested by Lauder Brunton. The patient is given a glassful of water every hour by mouth and every two hours a half pint of water containing an ounce of malt sugar is given per rectum to combat acidosis. Heat is applied to the abdomen over the dressings. The hot application is repeated several times a day for several days to combat adhesions and lessen pain. After the first day the patient is made to take several deep breaths every hour to empty the splanchnic vessels.

To insure complete emptying of the intestine, and to lessen the discomfort of the patient by getting rid of the gas which in these cases nearly always fills the small intestine and distends the colon, a dose of one ccm. of pituitrin extract is given immediately after the operation, and soon after the patient is transferred to his bed a hot enema (two or three pints) is administered. The addition to the enema of a half pint of molasses or, better, of malt extract, renders it much more effective. Sulphate of magnesium or glycerine (one ounce to the enema) may be used instead of molasses with good results. The patient is also given five grains of carmine in a capsule and an ounce of an emulsion of white paraffin oil. The appearance of oil floating upon the water returned after an enema and the carmine color afford certain evidence that material is passing through the valve.

When the patient suffers from an accumulation of gas, the enema is repeated until relief is obtained, the enema being allowed to return through the rectal tube. The efforts to move the bowels must be thorough and persistent but it must be remembered that the patient needs rest and sleep and must not be exhausted by over-attention.

A thorough evacuation of the intestine must be secured not later than the third day, and earlier is better.

The injection of pituitrin extract may be made daily for several days following the operation if necessary to insure complete bowel action.

Post-operative Care.—It is important to watch the urine with great care. The appearance of a large amount of indican is a very certain indication of ileac stasis. The amount of indican present should be estimated by the Folin method. Accumulation of gas in the small intestine is indicated by distention of the abdomen which is not relieved after evacuation of the colon by means of enemas.

The X-ray affords altogether the best method for determining the condition of the ileum. By means of the technic devised by Dr. James T.

Case, it is possible in every case to know the exact condition of the small intestine. When post-operative stasis exists, the intestine becomes distended with gas, and the gas-distended coils of the intestine are clearly shown by the X-rays, so that the surgeon need not remain in a state of uncertainty as to whether or not intestinal obstruction exists. The accuracy of this method is very great in skilled hands and its importance cannot be over-estimated. The writer requires as a routine practice in the hospital under his care the roentgenological examination on the second morning after operation in all cases in which the abdomen has been opened and vomiting is persistent and also when the bowels do not move satisfactorily. In doubtful cases, any uncertainty may be cleared up by giving bismuth or barium to facilitate the X-ray examination, and the examination should be repeated daily until the bowels move freely and all occasion for anxiety disappears. An X-ray examination by a competent röntgenologist is in these cases of the very greatest service and should be made a routine practice after laparotomy when nausea or vomiting persist or the bowels fail to move freely.

It is important to get the bowels moving normally as soon as possible. The ordinary plan of fasting or liquid diet is highly conducive to constipation. The use of anodynes to relieve pain operates in the same direction, as do also the rest in bed and the use of laxatives in preparation for the operation. Starvation leaves the bile, mucus and other secretions and wastes to accumulate and putrefy. Thin gruels and broths are little better than nothing. Laxatives cause a spastic condition of the descending and pelvic colon and greatly exaggerate the antiperistaltic movements which Cannon has shown have their origin in the transverse colon. This has been clearly demonstrated by Case.

To avoid these difficulties the patient is prepared for the operation by the free use of paraffin oil and bran or agar-agar. Enemas are given the night before and the morning of the day of operation.

After the operation, an enema is given at once and daily, and feeding with orange juice and other fruit juices and purées is begun at once, or as soon as nausea and vomiting cease when these are present. Food is the natural laxative. Fruit acids excite the gastric glands and so encourage the secretion of hydrochloric acid and also stimulate gastric and intestinal motility.

Malt sugar is also given freely, an ounce in half a pint of water every two hours when the patient is awake, or eight ounces daily. This combats acidosis, a condition to which persons long subject to intense intestinal toxæmia are especially liable.

On the third day porridge is added to the diet. This is made of a mixture of cereals, oatmeal, cornmeal and sterilized (cooked) bran. The porridge is made with eight parts of water to one of cereal and is cooked not longer than ten minutes. The patient receives four ounces of this porridge every four

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hours in connection with fruit purées and fruit juices. An ounce of paraffin oil or paraffin emulsion is given four times a day.

From day to day the variety of the diet is increased by the addition of green vegetables and vegetable purées. Medicinal laxatives of any sort are very rarely needed.

The patient is made so comfortable by direct and derivative applications of heat and by deft nursing that anodyne drugs are seldom required.

Post-operative Regimen.—In order to secure the best results after operation for repair of the ileocæcal valve, the patient should permanently adopt a regimen which will produce a definite change of the intestinal flora. The measures necessary to accomplish this the writer has described in other papers.¹

Since the publication of the first paper describing my operation for repair of the ileocæcal valve I have modified the original technic in several particulars. The results have improved as the following details have been more closely adhered to:

(1) Increase in the amount of invagination of the ileum, the optimum amount being three centimetres; (2) less constriction of the lumen of the gut at the point of junction; (3) avoiding any disturbance of adhesions about the terminal ileum when not clearly shown to be obstructive; (4) the administration of a dose of pituitrin extract (1 c.c.) directly after the operation and each day for two or three days until paraffin oil or carmine administered by mouth appears promptly and abundantly in the stools.

The advantages of the operation are fairly shown by the results obtained in a series of twenty-six cases operated between January 1 and December 31, 1915, and which were subject to a careful X-ray examination with reference to ileac stasis and the condition of the valve both before and after the operation.

Of the twenty-six cases in which before operation the valve was shown to be incompetent both by X-ray examination by Dr. Case and by testing the valve at the operating table after opening the abdomen, the valve was found competent after the operation in 23 cases or 88 per cent. In the one case in which the repair was not complete, the incompetency was accompanied by ileac stasis and there were marked adhesions about the terminal ileum and the pelvic colon. The latter were divided but the pelvic colon was not suspended. The operation memoranda show that only one invaginating suture was introduced (posterior) and that the ileum was turned in only two centimetres. The invaginated fold of gut should have been longer, a second suture should have been applied and the pelvic colon should have been suspended by the omentum.

As regards ileac stasis, the results were as follows: marked stasis existed before the operation in all but three (99248, 94728, 96384) cases as shown by the X-ray examination. In these three cases the clinical

¹Incompetency of the Ileocæcal Valve, Medical Record, June 21, 1913. Should the Colon be Sacrificed or May It be Reformed? Jour. A. M. A., June 30, 1917.

evidence of ileac stasis was present, and as all had been under treatment for two to five weeks and had been given liberal doses of paraffin oil and agar-agar or other mechanical stimulants, it is a fair presumption that ileac stasis was present and was temporarily masked by treatment. Of these three cases ileac stasis was found present in one (96384) after the operation, notwithstanding the fact that the valve was competent. The memoranda of the operation show that two sutures were placed and the lumen of the junction lessened $3\frac{1}{2}$ centimetres. It is probable that the constriction was slightly too great. Experience has convinced me that a very moderate degree of constriction is sufficient in case the small gut is infolded to the extent of 3 to $3\frac{1}{2}$ centimetres. It is probable that the excessive constriction soon disappeared, for two months later the patient reported herself as feeling well and much improved by the operation.

In three cases (97329, 94992, 95110) there was stasis both before and after operation. In one of these the post-operative stasis was slight. The operation memoranda show that in two of these cases a Lane's kink existed. In one case (97329) the kink was evidently not obstructive and was not disturbed. A single suture with 2 centimetres infold was applied. The repair was insufficient. In another case (95110) the adhesions of the terminal ileum were divided. The usual effect of this as shown by Dr. J. T. Case is to render the gut spastic for some time after the operation. This was probably the cause of the stasis. In the third case (94992) the ileal stasis may be fairly attributed to a gastric stasis of eight hours which existed before the operation and persisted after. Careful examination of the stomach at the time of operation showed no mechanical cause for the stasis.

The total result of the operation in the 26 cases as regards ileac stasis was complete relief of stasis in 22 cases or 84.6 per cent. Omitting the case in which the post-operative stasis was due to slow emptying of the stomach, the better result of 88.4 per cent. is shown.

As regards clinical results, it certainly cannot be claimed for this operation that it is a panacea for all chronic ailments, but that it does restore the function of the incompetent ileocaecal valve and that it does thus cause the disappearance of ileac stasis is clearly shown by the post-operative X-ray findings made by Dr. J. T. Case by his usual careful technic. If no other evidence of benefit from the operation than this could be produced, its performance would be amply justified; but abundant clinical evidence of benefit is available. Of the 26 cases comprised in this series, all of whom were operated more than six months before the writing of this paper, 18 (69 per cent.) replied to a circular letter in which mention was made of the leading symptoms for relief of which the operation was done, and the patient was asked to indicate which symptoms, if any, had disappeared, which had diminished, and which were unchanged.

Each one of the eighteen cases which replied reported improvement

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in one or more important particulars. In 9 cases (50 per cent.) practically all symptoms disappeared after the operation.

In view of the above evidence I think it fair to claim for the operation for repair of the ileocæcal valve the following advantages:

1. It removes the most common of all causes of ileac stasis by restoring the competency of the ileocæcal valve, and so relieves the stasis.

2. By curing ileac stasis it removes the cause of a large number of chronic morbid conditions which depend upon intestinal toxemia.

3. The simplicity of the operation and the fact that it is reparative and conservative in character, correcting an anatomical defect and restoring an important lost function, should recommend the operation in cases in which other structures are not so badly damaged by disease that more radical measures are indicated.

It must be constantly borne in mind that incompetency of the ileocæcal valve is an acquired defect and that it is secondary to a diseased condition of the distal half of the colon which contracts the lumen of the gut and leads to exaggerated antiperistalsis. In the four cases of the series in which ileac stasis was not completely relieved, adhesions of the pelvic colon existed in each case, and it is quite possible that the persistence of ileac stasis in these cases was in part at least due to a reproduction of the adhesions or to the spastic condition of the gut which commonly persists for some time after division of adhesions, or to an existing colitis which had not yet been completely cured.

It should be mentioned that in all the above cases lesions existed besides incompetency of the valve so that the operation was not done solely for the purpose of repair of the valve, although in quite a number of cases the symptoms properly attributable to incompetency of the valve were so pronounced that an operation expressly for repair of the valve might have been considered justifiable.

In concluding this paper the writer desires especially to emphasize three points.

1. Not every case of incompetency of the ileocæcal valve requires operation. In the writer's experience at least nineteen out of twenty cases may be relieved of all serious symptoms by a regimen which will combat intestinal putrefaction and secure two or three bowel movements daily, although of course the valve remains incompetent. Paraffin oil with agar-agar or sterilized wheat bran is highly useful and wonderfully efficient in these cases.

2. It is very rare indeed that the operation will be indicated without the presence of other conditions which in themselves constitute definite indications for operation, such as chronic appendicitis or adhesions of the pelvic colon or some other obstructive lesion.

3. Incompetency of the ileocæcal valve is always a result of some obstructive lesion of the colon. This lesion may be organic,—adhesions, tuberculosis, cancer; or functional—spastic contraction of the distal portion

of the colon, usually associated with colitis. No permanent benefit can be expected from any operation upon the ileocaecal valve unless the primary lesion of which it is a result is also successfully dealt with. Colitis must be cured by changing the intestinal flora. Any other cause of spastic contraction of the gut must be removed. The prolapsed and adherent pelvic colon must be released and suspended by the omentum so as to prevent recurrence of the obstructing adhesions. Neoplasms and other organic lesions must be dealt with when present, by appropriate procedures.

It must be remembered that practically the sole indication for the operation of repair of the ileocaecal valve is the relief of ileac stasis, by which is meant a delay of the bismuth or barium meal in the small intestine amounting to more than nine or ten hours after the ingestion of the meal. The more prolonged the stasis and the more serious the disorders arising from it, the more positive the indication for operation, provided of course, that other rational measures such as a bulky vegetable diet and the use of paraffin oil do not relieve the stasis and cause to disappear the secondary symptoms of stasis, such as headache, loss of appetite, foul breath, indicanuria, etc. Fortunately these non-surgical measures succeed in by far the great majority of cases. I desire to emphasize this point because I do not wish to be understood as maintaining that every person who is shown by X-ray examination to possess an incompetent ileocaecal valve should be advised to submit to an operation for repair of the valve. As a matter of fact all but a very small proportion of these cases may be made perfectly comfortable by an antitoxic and laxative diet. By cutting down the protein to the minimum requirement for tissue building, a quantity not exceeding ten per cent. of the total ration, estimated in calories, and by increasing the activity of the intestine to three or four efficient bowel movements a day so as to effect such complete and rapid clearance of the intestine from putrefiable food residues as to leave no opportunity for putrefactive changes, the evils resulting from incompetency of the ileocaecal valve may be made to rapidly disappear in by far the great majority of cases. The incorrigible cases are those in which obstructive lesions are present which so interfere with the normal action of the gut as to cause greatly exaggerated antiperistalsis and distention of the caecum and proximal colon with decomposition of food residues and body wastes.

The number of cases which have been definitely cured of ileac stasis by repair of the ileocaecal valve and removal of mechanical hinderances in the distal colon is now so considerable that I feel justified in making the claim that the lesions mentioned are the true cause of ileac stasis rather than Lane's kink, and in maintaining that when surgical interference becomes necessary the procedure indicated is the simple one of repair of the valve rather than the serious and mutilating operation of short-circuiting or of colectomy, except in cases in which the existence of neoplasms or other lesions positively obstructive in their nature can be clearly proven.

Dr. Case, who has studied röntgenologically all the cases in which I have

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repaired the ileocæcal valve, reports in an interesting paper the results of his observations as follows:

"I have already reported post-operative studies on more than one hundred cases in which this operation for restoration of the ileocæcal valve competency has been performed. With only three or four exceptions, the Röntgen-ray diagnosis of ileocolic valve incompetency was confirmed at operation, and the valve competency was restored by the simple operation above mentioned. That the competency was restored was proved, not only by testing the valve *in situ* before the abdomen was closed, but later by röntgenologic tests. Although, in several instances, more than a year and a half had elapsed since the operation was performed, in only three or four cases out of the hundred did subsequent röntgenoscopy find the valve incompetent.

"The effect of the operation on the emptying-time of the ileum has also been tested by the bismuth meal, but thus far no evidence has been secured which would lead me to believe that the operation has caused the slightest interference with the passage of ingested food from the ileum into the colon. On the contrary, the emptying-time of the ileum, which before the operation was in every single instance prolonged, has been definitely shortened, nearly always within eight hours."¹

In the same paper Dr. Case thus comprehensively summarizes the evidence of the essential importance of the ileocæcal valve anatomically and functionally:

"1. The ileocæcal valve is almost universally present in vertebrate animals; and, at least, in the dog, pig, and cat, the valve is competent to the enema, withstanding enormous distention of the colon by fluid and gas.

"2. By means of a string passed through the alimentary canal traction may be made on the valve lips, producing temporary incompetency.

"3. In about one-sixth of three thousand persons, most of them constipated and all suffering from gastro-intestinal disturbances, the bismuth enema passed the ileocæcal valve and filled the terminal ileum for varying distances.

"4. The valve incompetency thus determined is a constant phenomenon in these cases.

"5. Patients with incompetency of the ileocæcal valve describe characteristic disagreeable symptoms apparently due to passage of the enema into the small intestine.

"6. In the marked cases there is also observed a reflux of ingested bismuth from the colon back into the ileum.

"7. The occurrence of the incompetency is, to a large degree at least, independent of the temperature or composition of the opaque enema.

"8. The incompetent ileocolic valve may be restored to competency by a simple surgical procedure.

"9. In operation on patients with incompetent ileocolic valve the small bowel is found filled with gas to a very disturbing degree.

"10. It is possible in the operation of ileosigmoidostomy to construct an efficient artificial ileocolic valve which will successfully act as a barrier against reflux from the colon.

"11. Definite deviations from the normal anatomic structure are found at operation on cases of ileocæcal valve incompetency.

"12. Post-mortem studies show the ileocolic valve to be competent in the great majority of cases."

¹ Journal A. M. A., October 3, 1914.

DUMB-BELL STONE IN DIVERTICULUM OF URINARY BLADDER

BY SERGEANT PRICE MARTIN, M.D.

OF BUFFALO, NEW YORK

THE patient, a male, aged forty years, whose family history and previous medical history were negative, presented himself at the Mayo Clinic on April 19, 1916 (Case 157750 (J. H.)), complaining of difficulty in urination. He stated that he had been perfectly well in every way until seven years previously, when immediately after doing some heavy lifting, he became nauseated and for twenty-four hours was unable to urinate. At the end of that time he had to be catheterized, his doctor drawing off a large clot of blood before the flow of urine began. After this he remained well for six months, save that his stream would often shut off suddenly in the middle of urination. At the end of this time urine again stopped entirely, necessitating catheterization. Since then (a period of six and one-half years) he has been bothered nearly every time he urinated by his stream shutting off suddenly before he was through voiding. His bladder has never felt completely empty and for the past year he has been using a catheter once a week. He has had no frequency of urination and has never passed any blood, pus or gravel in his urine. He has never had any chills or fever. His general condition has been good in every way.

Physical examination showed a pale, well-nourished adult male; height five feet and six inches; weight 142 pounds, with all physical findings normal, save for a firm mass in the right posterior wall of the bladder, which could be easily palpated per rectum above the prostate.

Analysis of twelve-hour specimen of urine showed: amount, 450 c.c.; specific gravity, 1020; acid reaction; some albumin; no sugar; an occasional red blood-cell; pus in abundance.

An X-ray of the kidneys, ureters and urinary bladder (Fig. 1) showed a dumb-bell-shaped shadow in the right side of the bladder. The larger end of the shadow appeared about the size of a hen's egg, the smaller about the size of a robin's egg. They were connected by a narrow middle piece which appeared about the size of an ordinary lead pencil in diameter.

Cystoscopic examination showed a stone about the size of a robin's egg fixed to the right posterior wall of the bladder and apparently protruding from a diverticulum.

Operation (May 5, 1916).—An incision was made extending from the symphysis pubis to just below the umbilicus. The tissues and muscles were separated down to the bladder. The peritoneal covering of the bladder was then stripped back. A diverticulum two inches in diameter was exposed on the right posterior wall of the bladder, which was completely filled by the large portion of the stone,

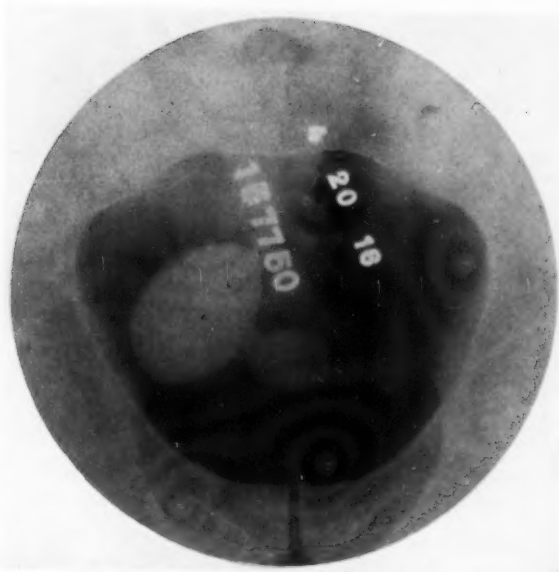


FIG. 1.—Skiagraph of calculus in diverticulum of the urinary bladder.

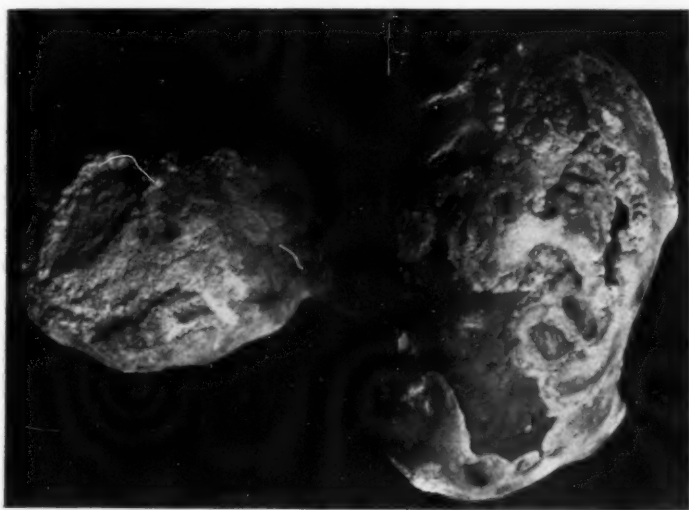
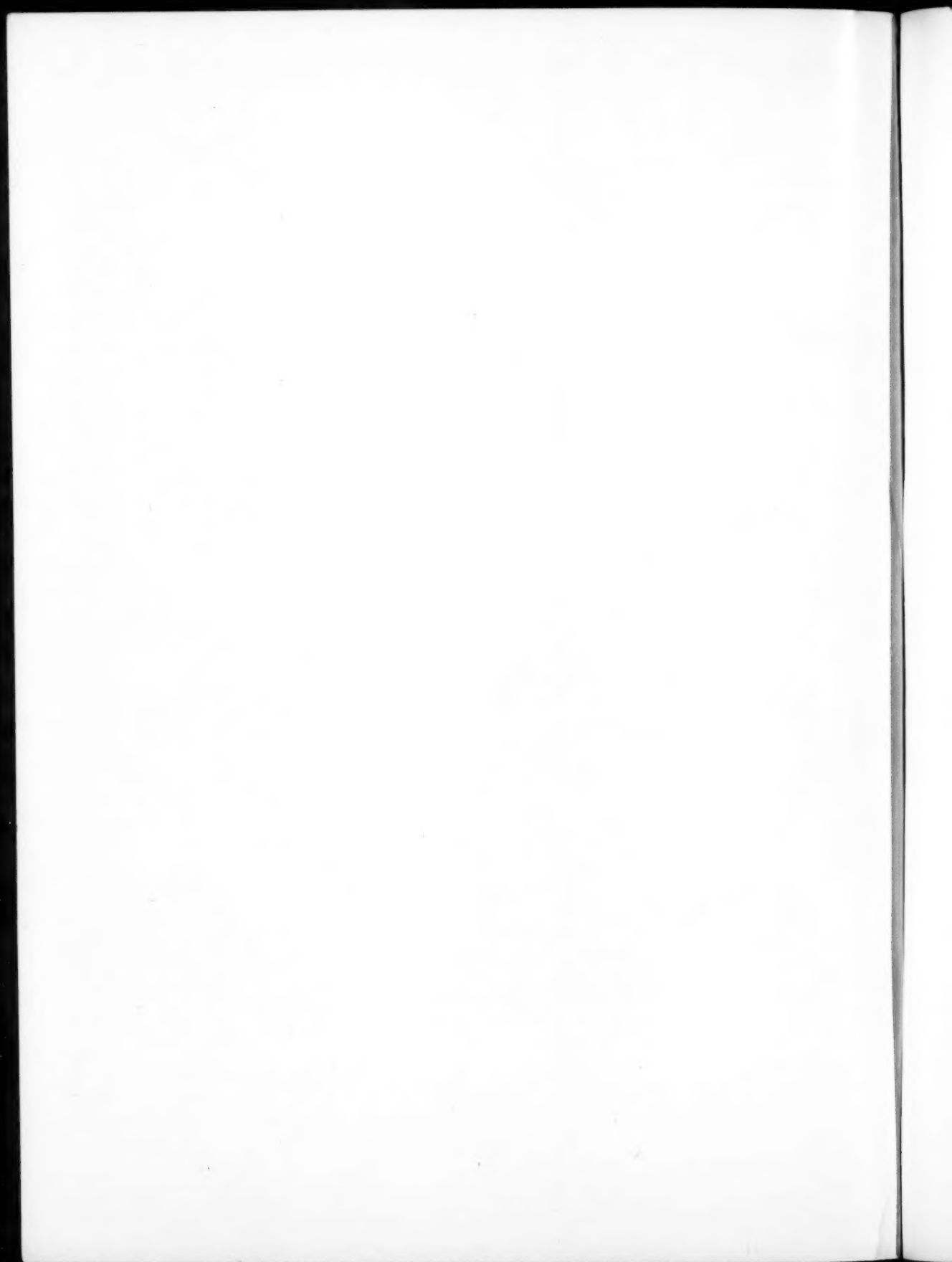


FIG. 2.—The calculus after removal.



DUMB-BELL STONE IN DIVERTICULUM OF BLADDER

which was 5 cm. long by 3 cm. in diameter. The diverticulum was opened and the stone was removed through this opening. Following this the sac of the diverticulum was excised and its opening into the bladder was closed by a series of interrupted sutures of chromic catgut, so taken as to invert the mucous membrane toward the bladder cavity. These were further strengthened by a continuous suture of chromic catgut. The recti muscles were brought together with interrupted sutures of Number 2 plain catgut. Fascia and skin were brought together by a figure-of-eight silkworm-gut, and the skin edges were held together by a continuous horse-hair suture. No drains were inserted. The small portion of the stone was 3 cm. long, with a diameter of 2 cm. The two portions were united by a narrow middle piece, which was $1\frac{1}{2}$ cm. in diameter (see Fig. 2).

A second cystoscopic examination made five weeks after the operation showed a normal bladder in every respect save for a slight scar on the right wall where the opening of the diverticulum had been.

A review of the literature of the past ten years on diverticula of the bladder discloses only few references to instances in which stones have been found in diverticulum. Thomas, in a recent complete study of all cases of diverticula examined in the Mayo Clinic during the past eight years, reported twenty-seven cases. In only three were stones found. Two of these each contained a single stone, while the third contained several small stones, but none were dumb-bell in shape nor of such great size.

NOTE.—The observations on this case were made by the writer while he was an assistant in the Urological Department of the Mayo Clinic. He wishes to thank Dr. W. F. Braasch, Head of the Section on Urology, for his courtesy in permitting the use of the material.

NOTES ON THE RECOGNITION OF CERTAIN LESIONS OF THE MALE BLADDER

BY ERNEST M. WATSON, M.D.

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FROM the introduction of the cystoscope by Nitze in 1876 and three years later perfected by the incandescent light bulb of Edison, the study of bladder lesions has been one rapid advance of diagnostic and therapeutic achievement. At first it was the grosser abnormalities and the technical manipulation of instruments that occupied the attention of workers in this field, but in recent years with the newer and more delicately constructed types of cystoscopes more attention has been given to detailed vesical study both for purposes of diagnosis and for treatment.

To-day the cystoscope with its various modifications is indispensable in the study and diagnosis of practically all urinary disorders. The success in the treatment of these conditions almost invariably depends upon the ability of the observer to interpret correctly the cystoscopic findings. In this brief consideration the following intravesical lesions will be discussed:

I. Prostatic changes: (a) Hypertrophy (benign): (1) Middle and lateral lobe involvement; (2) Albarran lobe involvement; (3) subtrigonal gland involvement. (b) No hypertrophy: (1) Median bar formation; (2) median bar with circular fibrosis. (c) Cysts of the prostate.

II. Trigonal hypertrophy.

III. Bladder changes due to spinal lesions.

IV. Vesical tumors: (a) Benign papilloma; (b) malignant growths.

V. Calculi: (a) Vesical calculi; (b) ureteral calculi (intramural).

VI. Vesical diverticula.

VII. Vesical tuberculosis.

VIII. Cystitis: (a) General cystitis; (b) localized cystitis.

In the study of a suspected prostatic after a careful clinical history and record of the urinary findings the palpation and digital examination of the prostate per rectum is the first step. This, however, gives one no detailed information as to the character of the intravesical prostatic enlargement, and this after all is most important. Through the cystoscope¹ the degree and exact type of glandular enlargement can be accurately determined. The more common type of intravesical hypertrophy is that which involves the middle and two lateral lobes singly or in various combinations. The anterior lobe is less frequently and, in fact, rarely hypertrophied. The middle lobe hypertrophy is determined by the oval or convex outline of the middle portion of the prostate when the lumen of the observation telescope is turned posteriorly, or looking backward toward the rectum. This

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curved or rounded margin, which should be followed around on either side toward the lateral aspects of the vesical orifice, to observe whether the enlargement is merely a rounded elevation distinctly raised above the trigone, or a definite lobe formation, with clefts between it and the lateral lobes, is diagnostic of middle lobe hypertrophy. In a similar way the cystoscope should be turned or rotated to bring into view successive segments of the prostatic orifice, observing the lateral aspects to determine in a like manner their contour or oval outline, for the enlargement of the lateral lobes is similarly determined. The normal prostatic outline in each segment shows instead of a convex border a slightly concave margin, except in the middle portion, where it is nearly straight or perhaps very slightly convex but with no appreciable elevation above the trigone. In addition to the marginal contour of the prostatic orifice as viewed with the cystoscope drawn well out so that the inner lens is just within the internal sphincter, the presence or absence of clefts or sulci between the lobes should be noted. The usual location of the clefts in a triple lobe hypertrophy is anteriorly (looking up toward the symphysis) where the two lateral lobes when hypertrophied join above, and posteriorly on either side of the median where the lateral lobes impinge on the middle lobe on the right and left sides. Not infrequently one or both lateral lobes join the median without any appreciable sulci, giving instead a continuous projecting mass of convex contour about the lateral and posterior aspects forming the so-called "collar type" of hypertrophy.

In hypertrophy of the Albarran group of glands² located in the submucous structures just below and within the internal sphincter posteriorly and at the apex of the trigone, the enlargement is noted as an elevation varying from a small thickening to a definite rounded protuberance similar to a middle lobe but situated a little farther within the bladder.

Still higher up occurs the group of glands known as the subtrigonal mass at about the middle of the trigonum vesicæ. This group by their important position, when involved in the hypertrophy, may cause as many if not more urinary symptoms than in the true prostatic hypertrophy. Upon the recognition of these different anatomical types of obstruction due to true hypertrophy of the tubular elements about the vesical orifice depends very largely the success of their operative removal. In their surgical treatment lies the only source of relief. This may be accomplished either suprapubically or by the perineal route. In the light of the lower mortality, greater comfort of the patient and shorter period in bed, the perineal method seems more to be desired unless there are definite contra-indications to it.

In addition to the hypertrophied types of obstructing prostates there is another group which is equally as troublesome symptomatically and particularly interesting and important from the standpoint of diagnosis and treatment. These are the so-called obstructing prostates with no hypertrophy, or "Prostatisme sans Prostate" as termed by Randall,³ who has recently given us a very comprehensive study of their history, diagnosis and

clinical importance. This group first described and studied by Guthrie⁴ and later by practically all the men whose names stand out among the makers of Urology during the past hundred years have come now to be known as the "median bar" type of obstruction. In these cases it is by cystoscopy alone that the diagnosis has to be made. Here the median portion of the prostate is seen through the observation cystoscope distinctly raised above the level of the trigone, and the outline is a very definite convex border, notably more rounded than normal, and as the margin is traced to either side it is found to fade away into a normal lateral contour in the right and left segments without any cleft formation. This shows no hypertrophy of the lateral lobes and by a trigonal study it is seen that the apex of the trigone is slightly, but nevertheless definitely, obscured by the elevation. For additional evidence an examination of the recto-urethral thickness should be made. This is done with a finger in the rectum and the cystoscope in the urethra, the beak turned posteriorly, when an accurate idea of the degree of thickness of the median portion of the prostate can be obtained by palpation between the finger and the shaft of the instrument.

Not infrequently instead of merely a median bar there is a definite thickening about all the segments of the orifice, similar to a sclerosis or the "*Contracteur du col de la Vessie*" of the French writers,⁵ yet not akin to a real "collar type" of hypertrophy which is a glandular enlargement but without any definite lobes or cleft formation. The diagnosis established in this class of obstructing prostates, the question of treatment is relatively simple. In the first place a prostatectomy is not necessary nor is it indicated. A procedure like Chetwood's galvano-cautery knife, Geraghty's knife for slitting the vesical orifice, fulguration as advised and practised by Randall, or Young's punch operation⁶ is of the type that bring the best results. Of these the punch operation of Young is perhaps the best, inasmuch as it is performed under novocaine entirely through the urethra, requiring the patient to remain in bed only three days and allowing him to leave the hospital in less than a week. The results in the cases for which it is adapted are excellent and there is practically no mortality.

Prostatic cysts play a very definite and important rôle in obstructions about the vesical orifice and in relatively young men, *i.e.*, under fifty years of age; with symptoms suggesting a true hypertrophy, but practically no hypertrophy per rectum, they have to be considered. Cysts to have a clinical importance have to be large enough to project into the vesical cavity and to be located fairly near the vesical mucosa. Cystoscopically they may simulate enlarged prostatic lobes and frequently when more than one is present typical clefts between them can be noted. They can be diagnosed by their translucency, mobility, and compressibility by the end of the cystoscope and if doubt still exists by aspirating their contents. In most cases they can be removed endo-vesically by means of fulguration, by excision with the wire snare or scissors or by the rongeur cystoscope of Young⁷ and only very rarely is a prostatectomy necessary.

II. *True hypertrophy of the trigone*, not the type of enlargement mentioned above due to changes in the subtrigonal group of glands, but rather a muscular hypertrophy, is a condition which occasionally occurs and when it does is deserving of considerable attention. This form of hypertrophy is usually secondary to some type of obstruction situated directly at the vesical orifice, *i.e.*, a general prostatic hypertrophy, a single middle lobe hypertrophy or a median bar formation. It appears to be the result of increased bladder activity in attempting to force urine through the obstructed orifice. Cystoscopically the trigone is seen considerably raised and generally hypertrophied and the inter-ureteric ligament particularly is in the form of a large ridge, back of which is a "bas fond" which may contain several hundred cubic centimetres of residual urine. In these cases which are found not rarely in relatively young men their urinary symptoms persist even after prostatectomy. The division of the inter-ureteric ligament and part of the trigone suprapubically and in some cases the excision of a wedge-shaped piece of the ligament is the only course that will give these individuals any benefit in addition to the removal of the obstruction at the orifice.

III. Another group of bladder lesions that is deserving of considerable study, particularly in the matter of differentiation from hypertrophic obstructive conditions, is the "*spinal bladders*."⁸ These, from the standpoint of the urologist, come to mean the bladders of early tabes and cerebro-spinal lues. Here we find that the bladder capacity is unusually large and the tonicity is poor as evidenced by its power to expel fluid through a catheter. Cystoscopically the bladder wall shows considerable trabeculation, usually a great deal, situated over the lateral and posterior walls in no characteristic arrangement. The trigone is rather small and definitely atrophic. The inter-ureteric ligament is also small and flat without much distinction between it and the bladder mucosa adjacent to it. The ureteral orifices are usually large, sometimes dilated, and often fail to contract on functioning. Perhaps most important of all, however, from a diagnostic standpoint is the condition of the internal sphincter, which is often found dilated. This is determined by the ability to withdraw the cystoscope out past the sphincter into the prostatic urethra and view clearly the verumontanum. As corroborative evidence cystograms and careful studies of the reflexes, the blood serum and the spinal fluid are important.⁹ In these patients when the findings are positive intraspinal therapy is indicated together with dilatations with the Kollman dilator and irrigations locally.

IV. The study of *bladder tumors* is a most interesting and important one cystoscopically. Clinically and practically the main issue is to determine whether the tumor is benign or malignant. The small pedunculated papilloma with the characteristic strawberry-like surface and particularly those with the fine filmy villi are usually benign. But when we find that the base or pedicle is wide and there is thickening of the adjacent bladder wall microscopic examination usually reveals a carcinomatous change. In addition most of the larger tumors have become carcinoma and have to be treated

accordingly. Whenever possible it is advisable to obtain a section for diagnosis, which can be done easily by means of the rongeur cystoscope. The benign papillomata respond best to fulguration, and even in the tumors of a questionable nature this is to be advised. Larger tumors, which fail to respond to fulguration, when so situated call for a resection. Other means at hand are radium combined with fulguration or resection to be used in suitable cases. In the frank cancer of the bladder most surgical means are of little value except as a palliative procedure. A total cystectomy, some years ago advised for otherwise inoperable cancer, has hardly stood the test of time as an advisable procedure in many instances.

V. *Vesical calculi* are readily and quickly diagnosed cystoscopically by their characteristic brownish or white color, by their mobility in the bladder and by their hard consistency when touched with the end of the cystoscope. Calculi in the intramural portion of the ureter should also be considered among vesical lesions.¹⁰ They oftentimes are diagnosed by the bulging or ballooning of the ureteral opening on the affected side, and also by the scratches on the wax-tipped catheter passed just within the ureteral orifice. X-rays and pyelogram studies should also be made in these cases, however, for confirmatory evidence. Vesical calculi of any considerable size demand a suprapubic cystotomy for their best removal. Smaller calculi are readily treated by litholapaxy and some even are readily removed by the rongeur cystoscope. Calculi in the intramural portion of the ureter can most always be removed without a major operation. The dilatation of the ureteral orifice with bougies, its fulguration to enlarge its lumen, the employment of the ureteral probang of Geraghty¹¹ or the injection of olive oil or papaverin are usually efficient means in causing the calculus to pass spontaneously.

VI. The presence of *diverticula* is usually noted cystoscopically before they are demonstrated by other means. They appear as dark or almost black cavities arising from the bladder wall itself and are often situated just outside the ureteral orifices on either side or in the vertex of the bladder. They may, however, arise from other sites, but rather infrequently. They vary greatly in size, from that of a small marble to a cavity larger than the bladder itself. Often it is possible to introduce the beak of the cystoscope into the cavity of the diverticulum and observe its contour, size and determine the presence or absence of calculi within it. Small diverticula in the absence of symptoms, particularly in old men, are better left alone. Larger diverticula, when found in young men who are good surgical risks, demand operative treatment, particularly if there is a bladder infection with any considerable amount of residual or if there are any calculi present. The removal of the diverticula is readily accomplished suprapubically by everting the sac of the diverticulum by suction into the bladder cavity followed by excision.

VII. Primary *tuberculosis of the bladder* may certainly be said to be extremely rare; some writers hold that there is never a primary tuberculous cystitis. When we find a small contracted bladder that is highly sensitive

LESIONS OF THE MALE BLADDER

and irritable, sometimes holding no more than 40-50 c.c. of urine, with a marked cystitis, tuberculosis is to be suspected. The bladder wall is usually markedly hyperæmic. This may be general or localized about one-half of the bladder or simply about one ureteral orifice. Often one ureteral orifice is entirely obscured in the inflammatory reaction. Ulceration may or may not be present, usually not in the early cases, but is almost universal in the older ones. Occasionally entire trabeculations are undermined and are observed suspended from either end across the bladder. In all cases where tuberculosis is suspected a careful study of the urine should be made for the acid-fast organisms. They are usually present and their demonstration is a matter of persistence in searching for them. All cases of tuberculous cystitis should be treated by eliminating the urogenital focus which is usually a kidney, an epididymis or the seminal vesicles. These possibilities must be ruled out before intelligent treatment can be instituted. Often the removal of the tuberculous focus causes a decided alleviation in the vesical symptoms, so that by antiseptic irrigations, internal medication, vaccine and by hydraulic vesical distention a relative cure can be hoped for, for a considerable period of time.

VIII. Accompanying practically all of the lesions mentioned above, particularly if they have existed for any length of time, there is usually a certain amount of *cystitis*. This also occurs from causes other than those mentioned above and on the whole is a very common lesion. It is noted by a hyperæmia of the bladder mucosa, and in the prominence and congestion of the blood-vessels. At times the inflammation may be of a catarrhal nature and flakes or clouds of mucus may be seen adherent to the bladder wall in almost diphtheritic form. Owing to the deposition of various urinary salts we encounter at times an encrusted cystitis, usually in strongly alkaline urines in which the various urinary crystals have become adherent to the inflamed mucosa. Occasionally we have the process after it has gone on to the breaking down of the mucosa, giving a real ulcerative cystitis (non-tubercular).

Another type of vesical inflammation called to our attention recently by Geraghty¹² is a localized resistant cystitis in distinction to those mentioned above which are usually generalized. This occurs mostly on the posterior wall and vertex of the bladder, seen best by a direct vision cystoscope, and frequently a mere star-shaped area of hyperæmia, but occasionally existing as a definite ulcer with an elevated puckered mucous membrane with broken edges. Most generalized cystitis (non-tubercular) is treated most satisfactorily by irrigations with the various silver preparations, usually the nitrate in various strengths and occasionally with argyrol or other newer synthetic compounds. In the localized forms the application of a strong nitrate solution direct to the affected area through a ureteral catheter under cystoscopic observation is employed with benefit. In the older resistant areas which still remain after all efforts to heal them an excision of the ulcerated patch is sometimes not only advisable but necessary to bring about a lasting cure.

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THE TREATMENT OF GONORRHŒAL EPIDIDYMITIS, COMPLICATED BY PERI-EPIDIDYMITIS

BY CHAS. S. VIVIAN, M.D.

OF HUMBOLDT, ARIZONA

WHILE conservative non-surgical methods of treating gonorrhœal epididymitis still have their advocates, the rationale of surgical intervention is widely recognized.

Pirogoff is credited with having done the first epididymotomy in 1852. Later H. Smith adopted the same procedure in 1864, puncturing the inflamed epididymis from the outside. Operative treatment then fell into disuse until revived in 1906 by Francis P. Hagner. The technic advocated by Hagner is that which, with minor changes, has been employed subsequently. Fundamentally all operative procedures thus far outlined, from the simplest needle puncture of the epididymis with aspiration of the infected foci, to drainage of cavities reached by puncture with a blunt probe, or sharp instrument, following incision of the skin and tunica, owe their success to the same principle. The difference in methods is one of degree, and each has been tried in selected cases. During the course of a gonorrhœa when the epididymitis develops the meatal discharge slackens very markedly or stops altogether. In cases treated expectantly, when the epididymitis begins to subside the meatal discharge returns in progressive volume in direct proportion as the swelling of the epididymis diminishes. This is true also in cases treated surgically. We may then easily conclude that during the height of the epididymitis some factor prevents discharge from the epididymis through the urethra. What is more apt to produce this than infiltrative, purulent, or scar pressure upon the tube in the epididymis? In further support of this belief, surgical intervention frequently fails to evacuate pus, and only a little serum exudes on the dressings, but the condition improves immediately, pain is rarely present after operation, and the temperature reaches normal, to remain so, in less than forty-eight hours. Coincident with this improvement, as has been pointed out above, the meatal discharge returns. Can we not then safely conclude that the pressure of the swelling which causes intense pain also prevents discharge?

The author believes that if after epididymotomy the temperature falls to normal within forty-eight hours and remains there, the method employed is adequate. Conversely, other factors being excluded, if the temperature does not reach normal within this period, sufficient relief of pressure has not been secured. Acting upon this belief, more radical measures were adopted in certain cases. The procedure used is, to the author's knowledge, not specifically described elsewhere in the literature in this connection,

although it is included in, or is incidental to, the technic of radical cure of hydrocele. Obstinate cases treated expectantly for a period of several weeks develop inflammatory adhesions between the testicle and epididymis on one hand and the enveloping tunica on the other. Very virulent acute cases if not immediately relieved produce similar pathology. These two classes of cases are the ones which relapse repeatedly or drag on indefinitely under medical management. The following technic was developed or borrowed to cope with the situation. Under ether or gas anæsthesia the scrotum of the affected side is opened by a long incision, as in the Bergman operation for hydrocele. The tunica, which is usually hardly recognizable because of its reddened, thickened, and friable character, is separated by sharp dissection from the underlying structures. It will be torn in places, and these sections should be removed. Both testicle and epididymis should be laid bare, bleeding points controlled by pressure or ligature, and if sufficient healthy tunica remains it may be sutured behind the testicle, as in the bottle operation. Any of the tunica which is of questionable soundness is better excised. The epididymis is now punctured by a blunt probe, which is made to enter all possible pockets, a few twisted silk-worm-gut sutures are inserted for drainage to be removed in forty-eight hours, and the scrotum is closed down to the drain. The cases treated in this manner by the author have left the hospital cured within ten days of operation, which in every case relieved the pain immediately and caused the temperature to reach normal within thirty-six hours.

Incidentally, hydrocele, which is frequently a bothersome and recurring complication, is adequately dealt with.

CONCLUSIONS

Epididymitis of long standing develops what might be called peri-epididymitis, which is best treated by the radical method described.

The epididymis has an opportunity to return to more nearly its normal size.

This method has the advantages of the other surgical measures without danger of relapse.

It provides the most free drainage possible.

Fulminating acute cases and cases which have been unsuccessfully treated in other ways are best suited for this procedure.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting, Held October 24, 1917

The President, WILLIAM A. DOWNES, M.D., in the chair

ULCER OF THE STOMACH WITH CARCINOMATOUS DEGENERATION

DR. FRANZ TOREK presented a woman, thirty-seven years of age, who had been ill for nine months, giving a history such as has been considered typical of duodenal ulcer—epigastric pain beginning three or four hours after meals and relieved by eating. The stomach contents showed the presence of 20 per cent. free acid and 36 per cent. total acid. The röntgenogram showed a defect in the region of the pylorus. On operation, an indurated area was found in the pyloric portion of the stomach, close to the pylorus, which appeared suggestive of a new growth and was therefore excised. The specimen, which is presented, consists in the main of a crater-like perforating ulcer extending to, but not through, the serous coat. The carcinomatous infiltration extends for a considerable distance into the muscular layers but does not penetrate the peritoneal coats.

Doctor Torek presented, also, a man who had an almost identical history and clinical findings,—duration two and a quarter years, pain two hours after meals, relieved by eating, free acid 26 per cent., total acid 40 per cent. The röntgenogram showed an ulcer at the pylorus. On operation, as in the first case, an indurated area was found close to the pylorus. The specimen shows a very small area of new growth. The main interest in this case is that although the carcinomatous area is so very small, tumor embolism in the vessels is plainly apparent in the microscopical section.

DR. ROBERT T. MORRIS presented a fresh specimen of papillomatous growth of the stomach, macroscopically polyadenoma, which he considered very unusual. The patient was a man 64 years of age referred to him with a diagnosis of carcinoma of the stomach. Laboratory findings showed an absence of free hydrochloric acid, an increase in lactic acid and the radiograph showed a small stomach fixed and without peristalsis. The history dated back only to last July. He had lost 40 pounds in weight, was quite cachectic; there had been no hemorrhage and no pain. The rapid development of symptoms suggested malignant growth involving the stomach only. After thoroughly acquainting the patient with the seriousness of the operation Dr. Morris removed the stomach, finding it small, hard, and wholly oedematous. He did not consider the glands in the vicinity of the stomach to be enlarged. The specimen showed adenocarcinoma of the stomach, with an area of especially marked oedema extending along the entire lesser curvature and showing a small malignant area at the pyloric end.

FRACTURE-DISLOCATION OF CERVICAL SPINE

DR. S. F. MATHEWS reported a case somewhat similar to those reported by Dr. Torek. On the removal of the pylorus the laboratory reported a condition of chronic ulcer, but later, carcinoma having been found in the lymph-nodes a reëxamination of the periphery of the ulcer showed undoubted carcinoma at one spot.

DR. FRANZ TOREK stated that about the time he operated upon the two cases reported he had another case of duodenal ulcer which on operation showed the same appearance as described for the gastric ulcers, that is the ulcer had an indurated base and he therefore considered it suspicious and excised it. Although the macroscopic appearance was similar to that of the gastric ulcers the microscopic examination showed no carcinomatous change, and he cited this instance as another proof of the well-known theory that whereas carcinomatous degeneration in ulcers of the stomach must be looked forward to, carcinomatous degeneration of duodenal ulcers is practically unknown.

FRACTURE-DISLOCATION OF THE CERVICAL SPINE

DR. A. S. TAYLOR presented a man, with the history that eight years ago he was thrown from a horse and was completely paralyzed from the waist down with loss of sphincteric control for three months. At the end of that time, as a result of electricity and massage, he recovered and remained well until January 19, 1917, when while working on the road he was struck by a trolley car and knocked down into an excavation. He could not tell how he landed and was taken to the Fordham Hospital in an unconscious condition. There were lacerations of his head, his nose was broken, and he was suffering from contusions all over his body. He recovered consciousness in twenty-four hours, and at that time his only complaint was a severe pain in the back of the neck, which became steadily worse. An X-ray picture of the skull showed no fractures; there had been bleeding from the nose and mouth when he was first brought into the hospital. On the 19th of February, one month after his admission to the hospital, he first came under Dr. Taylor's observation. At this time physical examination showed his eye reflexes normal. There was no Babinski, his gait and station were normal and there was no evidence of injury to the spinal cord. Rotation of the head was limited and caused excessive pain in the lower part of the neck on the left side. The neurologist who examined him located the source of pain pretty definitely in the posterior sixth cervical root, and an X-ray taken of his cervical spine disclosed a fracture dislocation between the fifth and sixth cervical vertebrae. With neurologic examination limiting the difficulty to the sixth root and with the above X-ray findings it seemed fair to do a division of the posterior sixth root of the left side to relieve the pain. Therefore on the 23d of February, a month and four days after the accident, Dr. Taylor did a left hemi-laminectomy, and divided the sixth posterior root. This resulted in complete relief from pain. At some point in the operation, however, there had been sufficient pressure upon the cord to cause practically a quadriplegia which persisted for seven days: there then appeared a little motion in the right foot, followed by motion in the

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left foot, finally motion in the arms. After five months of steady improvement the patient was discharged and given a position in the hospital in order to continue with his massage. He now shows no loss of function except in the left hand, where he has a typical ulnar paralysis deformity.

Dr. Taylor called attention to special points shown in this case, stating that in any case where there has been injury to the spine, where there has been very consistent severe pain always located in one spot, he considered it incumbent to have X-ray pictures made of the spine because it is common to have injuries of the spinal column which do not give cord symptoms, but which if neglected will give a great deal of trouble at a later date.

FRACTURE OF THE CERVICAL SPINE TREATED BY LAMINECTOMY

DR. CHARLES A. ELSBERG presented a woman who had been injured by a fall out of a hammock, resulting in complete quadriplegia at the level of the fourth and fifth cervical vertebrae. Surgical intervention was delayed for four or five days; during this time the condition became worse but she had some signs of sensation in one upper and one lower extremity, and some reflexes returned. Dr. Elsberg then did a wide decompressive laminectomy and divided one nerve root that was crushed. Dr. Elsberg advised this procedure in order to prevent subsequent root pains and stated that the same held good for nerve roots pressed on by tumors, in which case he considered it was advisable to divide the root if it was a posterior root. He stated that the case presented had gone to a very satisfactory recovery from complete paraplegia of the lower extremities with loss of power in one upper and considerable loss in the other upper extremity. The case presented at the present time only slight ankle-clonus in one lower limb and some deep pressure disturbance in one arm.

FRACTURE OF THE SPINE WITH CORD SYMPTOMS

DR. CHARLES A. ELSBERG read a paper with the above title for which see page 63.

DR. WILLY MEYER stated that he had followed more or less the principle of conservative treatment in recent fractures of the spine and had seen a number of cases with symptoms that first seemed to be very serious gradually improve. He had believed these to be cases in which a large effusion of blood had occurred within the spinal canal and that improvement was in part due to its gradual absorption. He felt that after Dr. Elsberg's lucid explanation derived from his large experience his own experience did not warrant his presenting a difference in opinion. He was much interested in the statement that if there is no transverse lesion and the cord is not completely destroyed one should in every instance operate at once.

DR. A. S. TAYLOR agreed with Dr. Elsberg in his statement that one should not operate in complete transverse lesions or in conditions simulating them. He stated that several experiences at the Fordham Hospital convinced him that fractures in the cervical area with symptoms of transverse lesions should never be touched. He reported three cases, occurring in one

FRACTURE OF SPINE WITH CORD SYMPTOMS

service, of fractures in the lower cervical region where the patients were in bad shape but were getting on, maintaining a fairly level condition in their general ill-being, all of whom died within twenty-four hours of operation. These patients had lived from three to four days awaiting neurological examination, and in each a wide laminectomy was done with the cord exposed well above and well below the immediate area of the lesion, but just as soon as the dura was split, in each of them the cord simply "mushed" out of the split like a custard. He believed this to be the cause of the promptly following death. Doctor Taylor did not agree with Doctor Elsberg in regard to the mild-symptom cases, and, although his experience had not been nearly so great, he cited two cases where non-operative treatment in one case gave a prompt and complete recovery in one young man of nineteen who had, in diving through the surf, had a fracture dislocation of the fifth cervical vertebra; at the end of the fourth or fifth day there was some return of reflexes and motion. X-ray showed displacement of the fifth forward on the sixth for three-eighths of an inch. An attempt was made to pull his neck out straight by extreme traction and to put a plaster collar on to hold his neck in a proper position and to give him extension both longitudinally and slightly posteriorly. At the end of a year there remained only a little disturbance of sensation in the tip of the right index finger. He was able to dance and swim and to drive his car. This patient had shown symptoms not of a complete transverse lesion but of a fairly severe one, and still non-operative treatment gave a perfect result. The second instance was a recent case of fracture of the second lumbar vertebra chiefly of the body. There was complete paraplegia below that level but at the end of a week or ten days there was return of sensation and partial return of sphincter control of bladder and rectum. Doctor Taylor stated that with so limited a number of cases as two it was impossible to make a hard and fast rule against operating on every one of his cases of fracture dislocation with only mild degree symptoms, but he did not believe that one should rush too promptly to operation in cases of mild degree symptoms.

Dr. Taylor called attention to a point in hospital technic which he considered might have an immediate bearing upon the progress in these spinal cord injuries. If one sees a broken back brought into the hospital, taken to the operating room, put on the table by the ordinary hospital orderly or other attendants one sees a thousand chances of doubling the already severe injury in transverse lesion of the cord. He stated that even a good house staff has no conception of what it means to handle a broken back. After an anæsthetization the patient is again turned on his face for operation, and once more turned back when put to bed. He stated that these many changes of position lead him to believe that more damage would accrue to the patient than would result in relief as the result of early operation. He suggested that he thought it wiser to wait until bone has formed to give a certain amount of rigidity to the broken spine when the handling necessary to operation could be better borne by the patient.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held October 1, 1917

The President, DR. CHARLES H. FRAZIER, in the Chair

CONGENITAL CLEFTS OF THE FACE

DR. JOHN B. ROBERTS presented a boy, three years of age, who was born with a unilateral cleft of the mouth at the right side, with minor vertical clefts of the upper lip and lower eyelids (Fig. 1).

The lateral cleft of the cheek at mouth is now closed by two operations done during the last few weeks (Fig. 2). The scar has not as yet become entirely smooth because the last stitches were taken out only yesterday. In closing these fissures from the corner of the mouth he had found it very important to take deep sutures a considerable distance from the edge of the cleft, because it is almost impossible to prevent infection from the saliva; and feeding and crying tend to tear out the sutures.

The first operation was done by simply paring off the mucous membrane of the cleft and inserting copper wire sutures from skin into mouth. About two-thirds of the cleft healed, leaving the mouth still a little prolonged and its corner turned up, giving the appearance of risibility. By a second operation at the corner, the tissues were so displaced as to make the two ends of the mouth almost the same in appearance. When the scar fades, his mouth will be quite symmetrical. The partial clefts in jaw of right side, and in the upper lip on left side, and the clefts in the lower eyelids are conspicuous. The mouth on the right side showed a lateral cleft before operation about one-third of an inch long. There was a slight atrophy of the right side of the face. This caused the cleft at the right side of the mouth to be directed a little obliquely upward.

From the end of the right cleft there is a shallow groove running upward and outward toward the outer canthus. This corresponds to a want of development in the right maxilla, in which a groove can be felt by pressure through the cheek. Inspection of the mouth shows a corresponding groove in the alveolus in front of the first molar, which is just coming through the gum.

The upper jaw on left side has a nodule below the orbital ridge just outside the usual exit of the infra-orbital nerve. Just above this nodule and corresponding with the position of the imperfection of the upper jaw is a notch in the lower lid about one-sixth of an inch from the inner canthus. Here the skin lines the floor of the notch and is continued as a band over the mucosa until it reaches the conjunctiva covering the sclera. There is then an extension of the band, triangular in shape, running up to the cornea upon the conjunctiva and an attachment within the anterior chamber to the edge of the iris at the pupil. The jaw on the left side appears to be normal. The cleft on the right side gave the child a laughing expression because the lower

CONGENITAL CLEFT OF THE FACE

lip extended around and upward and showed more mucous membrane than the upper lip. The two lips did not come quite together, exposing some of the upper teeth, giving the child a snarling expression and the mouth an oblique appearance, partly due to a want of development of the right side. The roof of the mouth shows an anteroposterior elevation running from front to back, corresponding to the curious fissure in the right maxilla. There is no cleft of uvula or palate. The uncomely expression has been much improved by the mouth operation.

The upper lip shows on its edge to the left of the median line a slight notch in the vermillion border and a groove in the muscle under the skin which runs up to the left nostril. The skin is normal. This congenital condition is due to an imperfect coalescence of the tissues in the embryo, the same in nature as, but less complete than, harelip. The boy's ears, penis and skull are normal, except that as already stated the maxillæ have some peculiarities.

Dr. Roberts also showed a wet specimen from the Mütter Surgical Museum, being an infant with bilateral cleft of the mouth. In this case Dr. Roberts operated soon after birth, on the right side, but the sutures had not sufficient hold to prevent them being torn out when the infant cried, because the suppuration occurring softened the tissues. Thus a very great strain occurred, particularly as only one side was operated upon. The result was that no union occurred. He should have taken a larger grasp of tissue in the sutures and have operated on both sides at the same time. While waiting for the general condition of the baby to improve it died from debility. The specimen shows the great gaping mouth stretching on both sides far out toward the ears.

He also showed the photograph of a child, three months old, with a facial cleft involving the left side of nose and the inner end of the left lower eyelid. The left ala of nose, part, if not all, of the lachrymal bone, and the intervening structures are congenitally absent. The lower border of the lachrymal lake and its floor are absent, though the orifice of the inferior canaliculus is seen at the angle of the part of the lower eyelid which exists. The tears run directly down into the cavity of the nose, because there is no upper part of the nasal duct. The absence of a lachrymal bony wall, made normally by the lachrymal bone, deprives the child of a bony channel at the orbital end.

To close this gap in the nose, he cut a flap from the left cheek with its pedicle just below the lower margin of the mandible, containing, he hoped, the facial artery uninjured. It was an error of judgment, perhaps, to try to close the whole opening at one operation, for the flap which was slid toward the median line and stitched to the raw edge of the cleft sloughed. Had he transferred a shorter flap with its pedicle near the angle of the mouth and closed first only the lower two-thirds of the opening, possibly this anæmic gangrene would not have occurred.

Akin to these vertical fissures in the face, due to non-closure of the embryonic fronto-oral bud with the lateral buds, are the congenital clefts in the upper lip and palate. These may leave the lip incomplete on one or both

sides of the median line, or divide alveolus and hard and soft palate. The extent and combinations of these orolabial fissures vary greatly. He once saw the bony palate incomplete at or near the middle line of the roof of the mouth, though the fissure was covered with normal mucous membrane. It showed plainly when the patient took a deep inhalation, through an open mouth, by the mucosa sinking into an anteroposterior furrow in the bone. He has now under observation a girl of about ten years, who has the flattened nostril and a notch in the edge of the lower lip sometimes seen after imperfectly repaired complete harelip and cleft alveolus. There is even a little continuation of red mucosa running up the lip on one side of the notch, similar to that seen occasionally after inaccurate adjustment of the edge by the operator. The photograph of this girl (Fig. 6) looks as if she had complete cleft of hard and soft palate, but the deformity is caused by the deep triangular arch of the palate shutting out the light and giving a black shadow.

There is no opening through the palate for even a probe. There exists a coalescence of two incisors, a curious deformity of both clavicles and a duplex great toe on one foot. The impression of the mouth made by Dr. J. V. Mershon shows well the curious anomaly. The child keeps the mouth open constantly, due to mouth-breathing and the impossibility now of closing her mouth because the posterior teeth strike. The lower jaw is not contracted. She also has defective vision and some nystagmus. Adenoid tissue on the nasopharynx and the tonsils has recently been removed.

The wide nostril and flattened nose of complete cleft of palate, alveolus and lip before operation are well illustrated in Figs. 8 and 9, taken before treatment, when the babies were a few weeks old. The projection of the intermaxilla occurring in some patients with bilateral cleft of palate, alveolus, and lip is shown in Fig. 10.

The ten-year-old girl (Fig. 6) looks as though the early fetal structures of palate, lip and alveolus had failed to unite until much later than usual; and then Nature had found it too late to make a good repair of the separated bones and undeveloped parts. Dental and surgical methods will be required for several years.

In Fig. 11 will be seen in a boy, 14 months old, who had cleft-lip and moderate cleft of palate, a notched appearance where the lip did not entirely unite, when operated upon a few weeks before the photograph was taken. The suture punctures have not yet become inconspicuous. This notch somewhat resembles the congenital deficiency in the upper lip of the little boy with bilateral cleft of the cheeks, shown in Fig. 1.

OPERATIVE SUGGESTION FOR WIDE BILATERAL CLEFT PALATE

DR. JOHN B. ROBERTS remarked that wide bilateral clefts of the hard palate, in mouths with low arch, present unusual operative difficulty. Muco-periosteal flaps, to be united across the gap without dangerous tension, and yet with the necessary broad contact of raw surfaces, may be unobtainable by the usual procedures. He recently had employed, in a very troublesome instance of complete double palatolabial fissure in an infant, a modification of



FIG. 1.—Lateral cleft of cheek and vertical cleft of upper lip and of lower eyelid.



FIG. 2.—Operative result in the case shown in Fig. 1.



FIG. 3.—Macrostoma bilateral cleft cheeks, congenital. Front view.



FIG. 4.—Bilateral cleft of cheeks. Lateral view of Fig. 3.



FIG. 5.—Facial cleft involving nose and eyelid. Outline of flap shown.



FIG. 6.—Congenital deformity with fused incisors and very high arch of palate.



FIG. 7.—Plastic cast of palate of case shown in Fig. 6.



FIG. 8.—Wide nostril and flattened nose in unilateral complete cleft of palate, alveolus and lip.



FIG. 9.—Wide nostrils and flattened nose in bilateral complete cleft of palate, alveolus and lip.



FIG. 10.—Projecting intermaxillary bone in cleft of palate, alveolus and lip (bilateral).



FIG. 11.—Notch in upper lip left after imperfect operation for closing a cleft of lip with cleft of palate on one side.



FIG. 12.—Diagrammatic illustration of method employed. (Photograph was not taken from patient who was treated by the method.) The flap outlined on the patient's left is upset towards the median line, the other flap is turned across the gap in the roof of the mouth and its end is sutured on top of the end of the upset flap.



FIG. 13.—Tie beams through cheeks to approximate the separated palatal masses in bilateral clefts of palate, alveolus and lip. Pads of gauze are shown under wires carried through cheeks.



FIG. 14.—Showing result secured of lip in the case shown in Fig. 12.



FIG. 15.—Plastic transplantation of cellulocutaneous flap from thigh or abdomen to face in plastic repair of nose, lips or chin. Hand showing skin surface of flap taken from thigh and satisfactorily used in rhinoplasty for syphilitic deformity of nose (Polyclinic patient). Note suture scars where flap has grown fast to ulnar side of hand. Opposite edge of flap shows thick pad of adipose tissue under skin. This border was sewed against raw surface of face, and the band cut loose from other border of flap two weeks later.

BILATERAL CLEFT PALATE

the usual methods, which, so far as he knew, had not been employed by operators, with whose uranoplastic work he was familiar. It is a sort of combination of Lane's method with the Davies-Colley principle.

On the left side, he dissected up a tongue-shaped flap from the top of the alveolus and the adjoining palatal surface, with its pedicle containing the posterior palatine vessels. The median incision extended along the margin of the cleft backwards to a point a little beyond the posterior edge of the palate plate of the palate bone. The external incision, somewhat parallel to this, was made between the outer surface of the alveolus and the cheek. These two cuts were joined by a transverse cut across the gum and palate not far from the anterior end of the cleft alveolus on the same side. The long flap so outlined was raised by peeling, with a dull raspator, the mucosa and periosteum from the top of the bony structures, leaving the unerrupted teeth and bared bone exposed. By carrying the buccal cut further backward than the median one, the mucoperiosteal flap torn up from the underlying bones was upset, as in Lane's operation, to present its mucous surface toward the cavity of the mouth. On the right side of the mouth a flap, similar in shape, was raised from alveolar and palatal structures, with its pedicle, however, in front, so as to include the blood supply from the anterior vessels of the palate external to the right side of the cleft. This flap, as was the left flap, was torn from the top of the alveolus and palate and included both mucosa and periosteum. Care was taken to lift both these flaps without using an edged tool under them. So-called palate knives with sharp edge or point are a delusion and a snare in raising flaps in uranoplasty. Curved or angular instruments without cutting edges are necessary to avoid dividing the vessels by which blood supply of the flaps is maintained.

The end of the second flap was slipped or drawn obliquely across the bilateral cleft in the roof of the mouth and laid upon the upset flap from the other side of the gap. Four or five mattress sutures of silver wire brought the raw surfaces in close contact over a considerable extent of surface. The eversion of the posterior flap required the incision on its outer side to be carried further backward than the median cut. It may be carried inward a little at its back, to facilitate the turning over of the flap. The anterior flap may need its external incision carried forwards a little to permit rotation at its base. In both instances care must be observed to put no tension on the pedicle which may compress the vessels and cut off the circulation in the flaps. The free ends of both flaps should be made broad, to give wide contact when sutures are inserted in the overlapping ends of the flaps. An oblique bridge is made across the wide gap in the roof of the mouth by this operation, which gives a start for further operative plastic work.

The case in which he used this method a few weeks ago has now a substantial bridge. The child had double cleft of the soft and hard palate, alveolus and lip, with projection of the intermaxillary bone. When he was about two weeks old, Dr. Roberts had pushed back the intermaxillary protrusion, after excising a V-shaped piece of the nasal septum, and wired the alveolus on both sides to the intermaxilla. The tension caused the wire to

cut out and the accompanying closure of the two clefts in the upper lip was followed by suppuration and absolute failure. Twice more an endeavor was made to remedy the lip clefts by plastic operation. On one of these occasions the child developed erysipelas, which spread over head and back and was accompanied by double otitis media. The boy at the time of the final operation was about five months old.

His general condition is now good and it is Dr. Roberts' intention to operate for further closure of the anterior part of the palate in about two weeks. This he shall probably do by the method described to the Academy about a year ago; that is to carry wire sutures through the skin of the cheeks to perforate the two maxillæ and draw the soft bones together in front by twisting the wires on the cheek, much as Brophy does, with intra-oral tie-beams and lead plates within the cheeks (see Figs. 13 and 14).

In great absence of tissue in lips or nose the surgeon may obtain tissue from abdomen or thigh by using hand as transporting agent (see Fig. 15).

PEDICLED ABDOMINAL TRANSPLANT FOR CONTRACTURE OF FINGER

DR. P. G. SKILLERN, JR., presented a boy, aged twelve years, who was admitted to the Polyclinic Hospital (Case Record No. 31562), service of Dr. G. P. Müller, on June 26, 1917. Two months before admission he picked at a callus on the palmar aspect of the base of the right middle finger. Infection followed. The abscess was incised by another surgeon, the incision extending in the midline from the middle of the second phalanx across the two proximal flexion creases of the finger to its root. After healing had taken place contraction of the scar followed and went on until the finger was drawn down toward the palm, preventing forcible extension. This median scar was ridge-like and consisted of keloid cicatricial tissue.

June 27, 1917, under local novocaine anæsthesia, Dr. Skillern excised the scar in a rectangular manner, exposing unopened sheath of flexor tendons; the raw surface was covered by an abdominal flap which was stitched to the edges of the wound in the finger. Dressing applied. Limb bound to side.

July 9, 1917, the base of the flap was severed and the flap tacked down into the proximal portion of the skin wound. The abdominal wound was closed. The transplant healed soundly in place; at first redundant it is now growing smaller and adapting itself to the size of the finger. It forms a soft cushion covering the front of the proximal phalanx. It in no way incommodes the patient. The patient has recovered complete function, with the exception of the power of hyperextension.

Dr. Skillern remarked that this case illustrates the teaching of the late Dr. John B. Murphy, that an incision should never be made across a flexion crease. Progressive contraction is the inevitable result. It also shows the method of effectively correcting the deformity, namely, by a pedicled transplant. A copious blood-supply to this graft was insured by aiming to have the superficial epigastric artery in the middle of the pedicled transplant during the twelve days the latter was "taking."

DR. A. BRUCE GILL said that about four months ago he had a case some-

TRANSVERSE INCISION FOR ACUTE APPENDICITIS

what similar to that reported by Dr. Skillern. A man, forty-seven years old, a leather-worker, had cut the middle finger on his left hand on a fence twelve years previously. The finger had become contracted so that it interfered seriously with his work. Dr. Gill excised the scar tissue which extended from the palmar crease to beyond the proximal interphalangeal joint. It was then found that the flexor tendons were contracted. They were lengthened. The proximal interphalangeal joint could now be extended and flexed by force, but it moved with a snap, as all the soft structures about the joint were contracted. Therefore, about three-eighths to one-half inch was removed from the distal end of the proximal phalanx to allow free motion in the joint.

The pouch of skin behind this joint was used in part to cover the joint in front. The remaining area of the wound was covered with a pedicled skin graft from the thigh. The hand was held to the thigh in a comfortable position by a light plaster case in which a window was cut for the dressing of the wound. Union had taken place at the end of two weeks and the graft was then cut loose from the thigh.

Contraction and thickening of such a graft always occurs. This makes a thick pad of skin on the hand which may interfere with the work of the patient and which is unsightly. In time the thickness of the graft becomes much less. In the case here reported he proposed to perform a second plastic operation to reduce the thickness of the graft.

DR. JOHN B. ROBERTS said that he had used the pedicled flap in the hand after excising Dupuytren's contraction. A cushion of skin and fascia remains somewhat as in this case. It would be easy to excise a piece and lessen the bulk as suggested by Dr. Gill. He had used in partial rhinoplasty the method of obtaining the flap described by Dr. Skillern. An abdominal or femoral flap is fastened to the ulnar edge of the hand, on which the surgeon has made an incision and laid the edges apart, so as to expose the underlying tissues for a half inch in width and two or three inches in length. After two weeks the thick flap of skin and superficial fascia is cut loose from the thigh or abdomen (Fig. 14). Then the hand is placed close to the face and the free edge of the cellulocutaneous flap stitched to the border of the rawed surface previously prepared in the nasal or oral region. Two weeks later the hand is cut loose from the flap which remains fastened to the face, and later is modelled to repair nose, lip, or chin. One can also obtain in this way tissue for plastic repair of the lip or chin by attaching a flap to hand and later applying it to face. Many amputations of fingers can be avoided by taking skin from the abdominal wall to cover the bones in the manner so well described by Dr. Skillern. He was convinced that many fingers have been needlessly sacrificed.

THE TRANSVERSE (DAVIS) INCISION FOR ACUTE APPENDICITIS, WITH SPECIAL REFERENCE TO THE APPENDIX CHAMBER

DR. P. G. SKILLERN, JR., reported the following cases:

Case I is a boy, twelve years of age, who had perforative appendicitis, for which the entire operation was done under novocaine anæsthesia, using a $\frac{1}{2}$

per cent. solution without adrenalin. The boy had been sick for five days with pain (at first referred to navel, soon localizing in right iliac fossa) followed by nausea and vomiting, fever ($99\frac{3}{4}^{\circ}$ F.) and leukocytosis (16,500). There were moderate rigidity of the right rectus and right flank muscles, acute tenderness on pressure between spinonavel line and Poupart's ligament, and induration in pelvis as revealed by rectal palpation. The incision began $\frac{1}{4}$ inch to inner side of anterior superior iliac spine and passed horizontally across to the midline—a distance of about 4 inches. The anterior sheath of the rectus muscle was cut across and the muscle retracted inward. The linea semilunaris and the posterior sheath of the rectus (close to Douglas's semilunar fold) were divided. The external oblique aponeurosis and the internal oblique and transversalis muscle aponeuroses and muscular fibres were separated with the fingers out to the iliac spine. The transversalis fascia and peritoneum were divided transversely between forceps. The anterior wall of the cæcum presented itself and prolapsed through the wound. With the finger the appendix was traced to its tip, which lay in the pelvis amidst coils of ileum, which formed the left wall of the abscess cavity, as well as the upper wall, the right wall being formed by the cæcum and side of the pelvis. The appendix was perforated near its tip. The appendiceal vein was the seat of thrombophlebitis, feeling like a match-stick. Drainage consisted of one Mikulicz and one rubber tube: these drains were brought out through the lateral angle of the incision close to the anterior superior iliac spine, and between the pelvis and their point of emergence were bounded above by the cæcum and below by the iliac fossa. Wound sutured in tiers up to drainage.

Owing to the thrombophlebitis of the appendiceal vein, which was found at operation, this patient was kept in bed until the danger of ascending infection of the portal venous system or detachment of an embolus from the thrombus had passed. This thrombophlebitis process maintained an irregular fever for three weeks, and when the fever finally abated and the leukocyte count fell to normal, it was presumed that the thrombus had become organized, so that the patient was allowed out of bed at the end of the fourth week. The wound is firmly healed; there is not the slightest suggestion of a weak spot in the scar.

In Cases II and III, when relaxed by ether, a definite mass the size of a plum could be felt in both just above the outer half of Poupart's ligament. The transverse incision in its outer portion gave a very satisfactory free exposure of the mass, which in each instance proved to be the acutely inflamed and distended appendix surrounded by fresh plastic lymph exudate and wrapped by the acutely inflamed and hyperplastic omental edge. This mass was contained in a little chamber bounded in front by the anterior abdominal wall; behind by the iliac fossa; externally by the lateral abdominal wall; internally by the terminal coil of ileum and meso-appendix; below by Poupart's ligament; and above and in front by the towering cæcum, which is usually covered by the omentum.

This *appendix chamber* as it should be called—just as Birmingham in

Cunningham's "Anatomy" speaks of the "stomach chamber"—adds a very forceful argument in favor of the transverse incision for acute appendicitis. The danger zones of this appendix chamber are the upper wall and the inner wall. The upper wall is usually—except in children and in those with thin, short and poorly developed omental aprons—effectively sealed by the omentum, whose edge swells up with an army of phagocytes and offers an impenetrable front to the spread of infection in the upward and forward direction. The inner wall is the most vulnerable because unreliably sealed by the hyperplastic meso-appendix and the terminal and other coils of ileum: the pelvic cavity, too, forms a safety outlet or sewer for toxic exudates, and to this extent compensates for the deficiency of the inner wall. In the usual case of appendicitis with abscess, therefore, the safest approach to the appendix chamber is from below, in front, and externally, and this zone corresponds to the safest and most effective drainage outlet for the appendix chamber. This drainage track extends from the bottom of Douglas's cul-de-sac outward between the cæcum above and Poupart's ligament below to near the anterior superior iliac spine, just below and to the inner side of which it emerges. When operating under local anæsthesia one can see the internal oblique muscle by its contractions grasp the drainage material snugly with a soft pad of muscle tissue, and here at the very close of the operation one sees inaugurated that very effective mechanism that prevents post-operative hernia and that forms the principles upon which McBurney's gridiron incision is based, namely, to separate the muscles in the direction of their fibres and to push aside without injury the motor nerves.

The vertical incision through the right rectus is objectionable in the first instance because it necessitates approaching the appendix chamber from within outward, thus entering the chamber by breaking through its inner defensive wall, thereby exposing the general peritoneal cavity to diffuse infection. Drainage through a right rectus incision is by no means ideal: it occupies an undesirable relationship with both the appendix chamber and the general peritoneal cavity. Again, the vertical incision is objectionable because it violates the McBurney incision principles: it cuts across the muscles and cuts across the nerves. Strictly speaking it does not divide the muscle fibres, but it divides the tendon fibres, which form the rectus sheaths. These aponeurotic tendon sheets are formed by minute tendon units which run transversely, and as a practical surgical proposition it is just as noxious to cut across tendons as it is to cut across muscle fibres. When the operator comes to sew up the vertical wound he may notice when closing the posterior rectus sheath that the sutures tend to cut through and pull out toward the incision in the sheath. Post-operative intestinal distention puts an immediate strain upon the posterior rectus sheath, causing a little gap between every pair of suture holes, and forcing through each gap a pellet of subperitoneal fat—a condition that gives rise to much of the scar discomfort which is often erroneously attributed to the presence of adhesions. This undesirable feature of the vertical incision can be obviated by imbricating the posterior rectus

sheath, but this is technically difficult and time-consuming. With the vertical incision it is impossible to avoid contusing, lacerating, or even dividing the motor nerves, unless one can work through a very short vertical incision, in which case the nerve or two exposed in the field may be gently drawn aside. It must be acknowledged, however, that division of these nerves so close to their termination is not so damaging as their more external division, for in the former instance the inner strip of the rectus is all that can be paralyzed. Drainage through a vertical incision is more liable to result in post-operative ventral hernia than drainage through a transverse incision. From the cosmetic standpoint the vertical incision scar is liable to become unsightly, while on the other hand—unless keloid change supervenes—the transverse incision scar eventually becomes almost imperceptible, for the natural tendency of the superficial layers of the abdominal wall is to fall into transverse creases, just as is the case with the skin covering the neck.

In concluding these observations he again called attention to the appendix chamber which he had described, feeling that its consideration from the surgical standpoint forms a basis not only for the rational method of dealing with the usual case of acute appendicitis with abscess, but also for one of the arguments favoring the transverse incision. In addition, the transverse incision is anatomically, physiologically, pathologically and cosmetically far superior to the vertical incision. In closing up the transverse incision it will be noted that the undivided rectus muscle falls across the inner half of the wound, forming a perfect barrier against hernia through this portion. Finally, the treacherous deep epigastric artery can be freely exposed and retracted inward out of harm's way when the transverse incision is employed, whereas with the vertical incision it is neither so easily revealed nor so readily avoided, and when divided it is capable of giving rise to very troublesome bleeding and even to death from post-operative hemorrhage (see article by the reporter in *ANNALS OF SURGERY*, April, 1917, 451).

DR. GEORGE P. MÜLLER agreed with Dr. Skillern in objecting to the vertical right rectus incision in acute appendicitis, and for the same reason. He used the McBurney incision almost entirely and had no difficulty in handling the pathology within the abdomen. The opening can be made as small or as large as wished, and if the suggestion of Judd is followed and the rectus muscle exposed, it can be so pulled inwards as to give a very large exposure. He did not see that there was anything materially different in the transverse incision from the McBurney incision because it does not matter which way the skin is cut. He never used the McBurney incision in chronic cases where there might be duodenal ulcer above or pelvic disease below.

DR. GWILYM G. DAVIS said that he was interested at the time this incision was proposed to find out what was the favorite incision in appendicitis. From the fact that in this neighborhood the longitudinal incision alongside the rectus was used so much he assumed that that might be the favorite incision everywhere. He found, however, upon inquiry, that the favorite incision was that of McBurney. At a surgical meeting he once saw a demonstration of McBurney's operation in which a surgeon thought the case was

FACIAL CARBUNCLE

not a suppurative one, but in which it turned out to be such. The exposure which he obtained on that occasion did not impress him favorably. He even yet could hardly see why the McBurney incision for suppurative cases is considered a really desirable one. He had always preferred the method which Dr. Skillern had described. The incision for the subacute cases can be made quite small. If, however, a supposedly mild appendicitis turn out to be otherwise, presenting adhesions or other difficulties, unless one has a good exposure one may perforate and tear the intestines. The small incision can then be enlarged by splitting the sheath of the rectus transversely over the muscle fibres clear across. It may be split to the median line, giving then an incision extending from the median line over to the anterior superior spine. If necessary it can be carried still along the crest of the ilium. With such an incision the surgeon can insert the hand and reach into the pelvis. If an operation on the gall-bladder is required, personally, he preferred to close the transverse incision opposite the anterior superior spine and make a separate incision above rather than to make one extremely long cut to expose both localities.

DR. EDWARD MARTIN said that this muscle-splitting operation which Dr. Skillern describes, he, together with many other surgeons, had been using for many years. The advantage of the transverse skin cut is, of course, incident to the fact that changes in custom are constantly occurring and there may come a day when a scar in this region may be conspicuously disfiguring. The method of approach is satisfactory in nearly all cases.

FACIAL CARBUNCLE, SINUS THROMBOSIS

DR. WM. J. RYAN said that the cavernous sinus, though less frequently affected with thrombosis than the other large sinuses, may become infected through the veins even though the seat of the trouble is apparently far removed. Such infection occurs by way of the extra-orbital connections of the ophthalmic veins, the superior and inferior, from cancrum oris, alveolo-dental periostitis, etc., which are also in communication with the facial veins.¹ Thus carbuncle of the face may be followed by cavernous sinus thrombosis. In the presence of thrombosis of the cavernous sinus two groups of pressure symptoms may be present: (a) venous, causing exophthalmos, œdema of the lids and of the corresponding side of the root of the nose, and chemosis; (b) nervous, causing ptosis, strabismus and variations of the pupil, pain, etc.

In illustration he reported a case taken from the records of the service of Dr. George P. Müller in the St. Agnes Hospital. The patient was a girl, nineteen years of age, who was admitted on February 7, 1917, with swelling and redness of the upper lip, swelling and œdema of both cheeks and of the right submaxillary region.

Five days before admission she noticed a pimple on the skin surface of the upper lip. She did not remember picking it. The lip became greatly swollen, but not very tender.

¹ Piersol: Human Anatomy.

When admitted the upper lip was hard and swollen and was the seat of numerous pustules. Both eyes and lids were swollen. Both cheeks, especially the right, and the right submaxillary region were hard and brawny. There was also a moderate submaxillary lymphadenitis. Temperature was 102° ; pulse 108; respiration 23.

Under ether anæsthesia an incision was made on each side of the midline of the skin surface, and corresponding incisions on the external mucous membrane. No free pus was seen, but the whole lip was a mass of sloughing tissue, with here and there a typical core. The lip was curetted through the four incisions and drained with rubber dam. A rubber coffer-dam was placed between the upper lip and the upper jaw, and allowed to extend over the lower lip so as to prevent any drainage running into the mouth. The whole face, except the eyes, was dressed with saturated magnesium sulphate dressings. The eyes were covered with wet boric acid compresses. The swelling of the face and submaxillary region was markedly reduced in twenty-four hours and had all disappeared the morning of the third day. The lip did not drain much but reduced in size daily until almost normal in contour. At the end of the second day she was somewhat restless. By this time there was some ptosis of the upper right eyelid, but no apparent exophthalmos. During the next day her restlessness did not abate, and that night she became very excitable, so much so as to necessitate the administration of morphine. On February 10, the second day after operation, all external swelling had practically gone, but the right eye was bulging considerably and the inferior palpebral conjunctiva began to avert. Ptosis of the upper lid was not very marked. She responded to conversation and had control of her sphincters (at this time). The next day the patient suddenly became very delirious; she vomited, and voided urine and fæces involuntarily. The dressings were removed from the face and the rubber dam removed from the mouth. The right exophthalmos was greatly increased. The eyelids could not be closed over the eyeballs. About 2 P.M. the patient became unconscious and died at 8.30 that evening.

It is to be regretted that autopsy was not allowed by her family.

THE USE OF DICHLORAMINE-T IN THE TREATMENT OF INFECTIONS AND WOUNDS

DR. WALTER E. LEE read a paper with the above title for which see page 14.

DR. PAUL A. LEWIS demonstrated an experiment improvised to emphasize the fact that the Dichloramine-T solution in oil gives off chlorine to water continuously over a number of hours, by taking a solution of starch and potassium iodide and floating the oil solution of Dichloramine-T on its surface. The test for free chlorine is dependent on the exhibition of free iodine; chlorine replaces the iodine in potassium iodide and sets iodine free, which free iodine gives the blue reaction with starch. If one mixes a watery solution containing free chlorine with this it will give immediately and completely the starch reaction for free iodine. It shows that the decomposition

DICHLORAMINE-T IN WOUNDS

is very gradual and continues for a long time. By adjusting these solutions a little differently one can show that the solution will become progressively more intense in its color during 24 hours.

Early in the spring Dr. Lewis visited Dr. Lee's surgical clinic where he had begun to use Dichloramine-T. The contrast between the condition of his patients and those seen in surgical dispensaries 10 or 15 years ago was so striking that he was convinced that unless some very radical change in surgical technic had taken place there must be something very good in Dichloramine-T. Visits to other clinics showed conclusively that no general advance in methods had taken place. This influenced him to try to oblige first Dr. Lee and Dr. Sweet in a very small way and to try to supply this solution for their use both here and abroad. The requests have increased in number gradually and it has seemed a duty, under the circumstances, for the Phipps Institute to supply what was needed to give a fair and extended trial to the material.

Laboratory men years ago had gradually come to the conclusion that what we know as a general antiseptic could be of little value in the treatment of infectious diseases or infected wounds. They had therefore been turning their attention to what they termed specific or partially specific disinfectants. Salvarsan is the outcome of that general idea. It is really revolutionary from the laboratory man's point of view that chlorine in any form should be found to be applicable in this way because chlorine is a general disinfectant and as such would have been expected to be a general protoplasmic poison; fully as destructive to tissue as to bacteria. It is an agent which destroys everything with which it comes in contact unless carefully controlled. The method of its control had never been developed until Dakin's studies led to the modified Labarraque's solution now known under his name. So adjusted, it has a certain disinfectant value in concentrations which do not destroy tissue. Dichloramine-T is a further advance in the direction of the controlled use of chlorine.

In another respect Dichloramine has been revolutionary. Koch thought that disinfectants in oil were useless. The fact is that this idea was based upon correct observation but it has no general application. Koch found that phenol, a strong disinfectant in water, was much reduced in activity by solution in a vegetable oil. These experiments were used as the basis of the generalization that disinfectants in oil were quite useless. Dichloramine-T shows that this generalization was incorrect and that oily solutions can be expected not only in the instance of Dichloramine-T but in other instances to do a great deal that water solutions will not do. Observations by Professor A. N. Richards and Mr. McMaster, during the past summer, have shown that phenol itself is less active as a disinfectant if dissolved in water than in a mineral oil. The whole question of disinfectants which are soluble in oil will have to be gone over again. We have made only the barest beginning of that work this summer.

Some have said that the Dichloramine-T is not a disinfectant, that all its value is due to the eucalyptol. It is easy to understand that in the present

chaotic condition of the question some one may have done an experiment which has led with more or less propriety to this conclusion. On the other hand, the experiments of Richards and McMaster do not lead to any such conclusion. He did not, however, consider that these experiments are by any means final or conclusive in the particular figures mentioned.

Phenol in a good grade of paraffin oil kills in 0.3 per cent.; eucalyptol fails to kill in 10 per cent. Chlorinated eucalyptol gives no killing in 100 per cent. in 24 hours; it is less active than eucalyptol. Dichloramine-T in solution has given very variable results; dissolved in chlorinated eucalyptol 0.3 per cent. has killed in 24 hours—equivalent to phenol. Dissolved in eucalyptol and paraffin oil in the hands of Richards and McMaster concentrations of from 0.03 per cent. to 0.002 per cent. have killed cultures. There can be no question that Dichloramine-T is a very strong disinfectant.

There is one other question which should be raised. We have no method really of contrasting properly or of stating on the basis of any of our laboratory tests what the therapeutic value of a disinfectant is going to be. The relative activities in test-tube as expressed in phenol coefficient, of course, mean nothing. We should know the relation between the disinfectant value and the amount that can be applied to the tissues, but have no satisfactory way of determining or expressing this. In this respect, without being able to be very precise either as to its exact disinfectant action or its exact ability to affect the tissues, we can say without question that Dichloramine-T is in a practical sense by all odds the strongest disinfectant that we have. We can apply to tissue at least once, and probably twice or three times, a 20 per cent. solution of Dichloramine-T in strong chlorinated eucalyptol. The solution is thus far stronger than phenol in the surgical sense because it is well known that a 5 per cent. solution of phenol cannot be safely applied and that a 1 per cent. solution may lead to gangrene if frequently applied.

CAPT. WM. H. FURNESS, M.R.C., said that for the use of Dichloramine-T in the treatment of contaminated and of infected wounds, the technic which Lieut. E. Lee devised, in contrast to the elaborate technic employed by Dr. Carrel in the use of Dakin's hypochlorite solution, is simplicity itself. The technic embodies, of course, the fundamental principles of surgery and of asepsis; beyond these there is but little required other than a knowledge of the chemical actions and reactions of the dichloramine, which Dr. Paul Lewis has so clearly and concisely demonstrated.

In surgical dispensary work, where all the cases are ambulatory, the treatment with Dichloramine-T can be carried out with such simplicity and system that the time required for a given number of dressings is less than one-third that required for the usual dressings with any of the other antiseptics, and the amount of gauze and of absorbent cotton and the number of bandages necessary is one-eighth of that ordinarily used.

The system consists of dividing up the work into three stages: the patients themselves remove the outer layers of bandage or of adhesive strips before coming up to the dressing table, but they leave in place the innermost dressing which covers the wound. The surgeon removes the inner dressing with

DICHLORAMINE-T IN WOUNDS

sterile forceps and then gives to the wound whatever attention it may require, such as removing sutures, blotting up excess of secretions, or oozing of blood, etc., and then the nurse, who attends to the sterilization of the instruments also, sprays the oil over the wound from an atomizer; the surgeon renews the four layers of gauze (all that is necessary) over the wound and the patient passes on to an assistant to have the dressing held in place by the fewest possible turns of a gauze bandage. Or the dressing may be held in place by means of short strips of rubber adhesive plaster provided with eyelet-hooks on one end. These strips are placed on either side of the dressing and a light rubber ring is laced across; this not only holds the gauze in place but allows free ventilation to the wounded surface—an important requisite in dichloramine dressings.

With such a system the average time required for the third or fourth day's dressing of the ordinary dispensary wounds is about thirty-five or forty seconds; the whole treatment of the wound is, however, performed with strict attention to asepsis, the surgeon's rubber-gloved hands touching nothing but sterilized instruments, and everything that comes in direct contact with the wounds has been carefully sterilized.

The articles required on the dispensary dressing table are as follows. This number of instruments is found to be necessary in order to keep up a constant rotation between the sterilizer and the trays for sterile and soiled instruments: A small electric or a gas sterilizer. Tray for sterile instruments. Tray for soiled instruments. Instruments: 6 pairs of dissecting forceps, 4 pairs of scissors (2 pairs of sharp points, 2 pairs curved), 2 pairs of hæmostats, 4 grooved directors, 1 Luer syringe with glass pipette, 1 pair sterilizer forceps. A glass atomizer, preferably one with a small reservoir attached directly to the spraying tube. Gauze dressings cut and folded in the following sizes: one and a half by two inches; two and a half by three and a half; and four by six inches. Cotton sponges; these should be, for convenience, about the size of a hickory-nut and wrapped in a single layer of gauze to prevent the cotton fibres from sticking in the wound. Small cotton applicators (on wooden sticks). A small medicine glass. An amber glass, glass-stoppered stock bottle of Dichloramine-T.

DR. GEORGE M. DORRANCE said that in his service at St. Agnes Hospital, they had had great difficulty in carrying out the Carrel method of treatment on account of the frequent changes in their nursing force, and the changes of residents and assistants. Their results, therefore, with the Carrel treatment have not been the results that Dr. Carrel reports. Their technic with the Dichloramine-T has not necessitated this refinement of technic and they have therefore been able to obtain more satisfactory results. Several cases stand out prominent in his mind: First, a knee-joint where half the outer surface of the joint was exposed and the joint was filled with street dirt. The wound was cleansed and a 20 per cent. oil used. The joint now is closed and a limited amount of motion is present. Case II, a stab wound of the pleura, was injected by the interne. This closed by primary union. In skin grafts they had been able to obtain takes in 85 per cent. of the grafts. Burns have

healed more rapidly and with less constitutional symptoms. Compound fractures which were infected and dirty from street dirt have healed more rapidly, and usually without any suppuration. In the smaller wounds, infections are seldom seen and the amount of dressings and dressing time have been greatly diminished.

In the use of this oil, one must not forget to adhere to the usual surgical principles and particularly stop all hemorrhage. A number of patients have complained of the amount of pain, but he does not think it is any greater than one experiences with the average dressing.

BIRTH INJURIES OF THE SHOULDER

DR. A. P. C. ASHHURST read a paper with the above title, for which see page 25.

GALL-STONE ILEUS

DR. E. J. KLOPP presented a gall-bladder and duodenum, with the following history:

The specimen is from a patient of sixty, who was admitted to the medical wards of the Jefferson Hospital December 15, 1915. She was jaundiced at ten years of age. No history of biliary colic. Has had a good deal of constipation. On December 12, three days prior to admission, she began to have anorexia, followed the next day by severe epigastric cramps which were intensified each time she took food. A high enema was effectual. She vomited frequently. Several purgatives were taken without result. On the day of admission the abdomen was rotund and obese but not distended, slight tenderness in the midline over the epigastrium. Vomiting ceased for five days. Nine days after admission she vomited again and rapidly became worse. She was transferred to the service of Dr. Stewart, to whom he was indebted for the privilege of operating. The abdomen was opened by an incision through the right rectus. A calculus was found in the mid-portion of the jejunum, which was removed through a linear incision of the bowel. The gut above the calculus was distended and dark in color, below it was collapsed and empty. Owing to the grave condition of the patient not much attention was given to the gall-bladder, which was imbedded in a mass of dense adhesions. The abdomen was closed without drainage. The patient died 18 hours after operation. At autopsy the coils of intestine were matted together, but were easily separated. The mid-portion of jejunum showed a neatly approximated suture line 4 cm. extending in long axis of bowel and covered with plastic exudate. Below this point the intestines were collapsed, above it they were distended, lustreless, purplish blue and friable. In the region of the gall-bladder was a mass of adhesions binding the lower surface of the liver, the pylorus and the duodenum together. At the junction of the first and second portions of the duodenum is an opening 3 cm. in diameter from which intestinal contents escape. On the under surface of the liver is a piece of gall-bladder 2 cm. in diameter bound up in adhesions; it has a thick fibrous wall and is empty.

BOOK REVIEWS

WHITE AND MARTIN'S GENITO-URINARY SURGERY AND VENEREAL DISEASES.

Tenth Edition. By EDWARD MARTIN, BENJAMIN A. THOMAS and STIRLING W. MOORHEAD. Octavo, pp. 929, profusely illustrated. J. B. Lippincott Company, 1917.

For twenty years this book of White and Martin has been a recognized authority in the field to which it is restricted. It is practical, full, judicial, accurate and clear, brief but comprehensive. It is a fitting monument to the activities and attainments of its senior author, the late J. William White, to whose memory this latest edition is dedicated.

LEWIS S. PILCHER.

A REFERENCE HANDBOOK OF THE MEDICAL SCIENCES. By various writers.

Third edition, edited by THOMAS LATHROP STEDMAN, complete in eight volumes. Imperial quarto, cloth. Illustrated by numerous chromolithographs, half tone and wood engravings. New York: William Wood & Company, 1913-1917.

Volume 8 of this very elaborate and comprehensive encyclopædia is now before us. The present edition has occupied four years in its production. It is now just thirty years since the publication of the first edition was completed under the able editorship of Dr. Albert H. Buck. The onerous duty of supervising a third edition in which much is new material has been very properly shifted by Dr. Buck from his shoulders to those of a younger man. We are glad to note, however, that the veteran editor has not entirely separated himself from this latest edition, but that, particularly in the domain of the History of Medicine and Biography, he has continued his contributions to it.

The title "Reference Handbook" is hardly descriptive of the extensive scope of the work. Under the name "Handbook" we naturally think of a small treatise that may easily be held in the hand. Instead of this, we have here a great quarto, ponderous, encyclopædic, reminding one typographically of the Century Dictionary more than anything else. We are assured by the publishers that previous editions have had a very large sale. This we can readily believe. The reviewer has during these many years often had occasion to refer to it and always with profit and advantage. In the present edition, not only has the matter in the previous edition been thoroughly revised, and in many cases rewritten, but a very large number of new subjects have been introduced and are given more or less extended treatment.

In opening this concluding volume one's attention is at once drawn to the very interesting and comprehensive article on the History of Surgery, from the pen of the veteran Stephen Smith. Especially the very full treatment of the Development of Surgery in America is worthy of note and the

BOOK REVIEWS

Profession of America should be grateful to Doctor Smith for having left this record of a development in which he might very properly say, "*Magna pars fui.*"

The articles on the Sympathetic Nervous System, upon Syphilis, upon the Thyroid Gland, and the Tonsils, are especially worthy of surgical note.

LEWIS S. PILCHER.

ABSTRACTS OF THE MEDICINE AND SURGERY OF THE WAR. A collection of articles by specialists working at the large base hospitals at the front, most of which have appeared from time to time in various medical journals. These short monographs are designed to allow the practitioner to keep abreast of the rapid strides made in both medicine and surgery in special lines in the Ambulance Hospitals, Base Hospitals and laboratories of the army. Published by Masson & Cie, Paris.

WOUNDS OF THE SKULL AND BRAIN, by C. CHATELIN and T. DE MARTEL, with a preface by Professor Pierre Marie, has recently been published in this Collection. There are 272 pages of text with 97 illustrations. Part I is upon Wounds of the Brain, by Doctor Chatelin, a neurologist, and is based upon his experience with 5000 patients examined and treated in the clinic of Professor Pierre Marie at the Salpêtrière. Part II is upon the surgical aspects of Wounds of the Skull, by Dr. T. De Martel, also an associate of Professor Pierre Marie at Salpêtrière. Many new points both in diagnosis and treatment are elaborated, and the details of the new operative technic and new instruments are fully illustrated.

In this series also has recently appeared a monograph upon **FRACTURES OF THE LOWER JAW**, by Professor LEON IMBERT and Dr. PIERRE REAL, with a preface by Dr. Ch. Fevier, Medical Inspector General. There are 151 pages, including 97 illustrations and five plate reproductions. Professor Imbert, from the Medical School of Marseille, in collaboration with Doctor Real, Dental Surgeon to the hospitals of Paris, presents the special subject of Fractures of the Lower Jaw in six chapters, covering the etiology, pathological anatomy, diagnosis and symptoms, prosthetic treatment, surgical treatment, and prognosis and end results. The illustrations are numerous.

FRACTURES OF THE ORBIT, by Professor FELIX LAGRANGE, belongs in this new series. There are 222 pages of text, with 77 illustrations and 6 reproductions of plates. This monograph presents the anatomy, types of fractures most common, with the modes of treatment and results. Unlike the two preceding articles, this is mainly a series of case histories illustrating the points of treatment and results obtained.

THE TREATMENT AND RESTORATION OF LESIONS OF THE NERVES, by Madame ATHANASSIO-BENISTY, interne of the Paris Hospitals, with a preface by Professor Pierre Marie, is the second volume upon the subject of nerve lesions by this author, the first volume being entitled *Clinical Forms of Nerve Lesions*. The present volume includes 178 pages of text with 62 illustrations and four pages of plate reproductions. The subject matter

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is concerned with macroscopical and microscopical lesions of the nerves, voluntary restoration of function, electrotherapy, surgical treatment, physiotherapy, orthopædic apparatus, and symptoms, diagnosis, and treatment of various types of paralysis.

A TREATISE ON REGIONAL SURGERY. By various authors, edited by JOHN FAIRBAIRN BINNIE, A.M., C.M., F.A.C.S., Kansas City, Missouri. Philadelphia: P. Blakiston's Son & Co.

The aim of this work is to present short monographs on the injuries and diseases of the different regions of the body. Volume one is written by thirteen different authors. It is stated in the announcement of volume one that there will be chapters upon the Head, the Branchial System, the Thorax and the Breast; and in volume two there will be chapters upon the Abdomen, the Genito-urinary System, and the Spine; and in volume three there will be chapters upon the Upper Extremity and the Lower Extremity. The first two volumes have appeared from the printer.

In so extensive a book, a summary of nearly all of surgery, it is extremely difficult to contribute in a brief book review a clear picture of what each author has covered in the subject assigned. Moreover, it is extremely difficult to form constructive criticism where such a large number of subjects appear in so small a space. Obviously in such a compendium of surgery, even though the separate chapters are pretty complete monographs of the subject in question, there must be a great variation in the quality of the work presented.

It would be aside the mark to criticise the wisdom of undertaking such a tremendous task as the editing of volumes of this sort. Dr. Binnie has chosen for the most part representative men as authors and each one has presented the subject entrusted to him in the form that appealed to him as most attractive.

The chapters in the first volume that deserve especial mention as being particularly well done are those by Joseph Bloodgood upon the Female Breast, and Samuel Robinson upon the Surgery of the Heart, Pericardium and Diaphragm. The three chapters by Charles H. Mayo upon the Thyroid, the Parathyroids, and the Thymus are written and illustrated in an authoritative manner. The chapter by J. E. Thompson upon Inflammatory Infections of the Neck is well done and introduces a new subject in a systematic surgery. J. E. Summers presents the subject of Injuries and Diseases of the Face and Jaw in a simple and instructive fashion.

Volume two, which covers the Abdomen, the Genito-urinary System, and the Spine, is as a whole better done than volume one. There are chapters upon diseases of the abdominal wall, hernia, the stomach and small intestines, the vermiform appendix, the large intestines, intestinal obstruction, the peritoneum and omentum, the rectum and anus, the liver, the pancreas, the spleen, the kidney and ureter, the bladder, the prostate, the external male genitalia, affections of the spinal column, and diseases of the spinal cord.

In glancing through the chapters of the second volume I am very much

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struck by the fact that the men who have written these various chapters are the men who have been devoting special attention to these particular subjects. I am also impressed by the fact that these monographs are not exhaustive treatises, but represent the knowledge each surgeon has upon the subject in hand.

Consequently I should say in criticising this book of Binnie's that it is distinctly a summary of the knowledge of individual special men upon each subject contributed. In this sense the surgery is an unusual one, and it is quite representative of American surgery. The volumes represent a group of special monographs written by special men, and in most instances are well conceived and well written.

It may be that it will always be necessary to possess a general surgery that covers all subjects. More and more in the future, I believe, however, that greater dependence will be had upon individual monographs rather than upon a general surgery. The present surgery may well represent the transition between these special monographs and the old-time general surgery in that it attempts to be a combination of both.

CHARLES L. SCUDDER.

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